BY ORDER OF THE SECRETARY OF THE AIR FORCE

AIR FORCE OCCUPATIONAL SAFETY AND HEALTH STANDARD 91-46

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Safety

MATERIALS HANDLING AND STORAGE EQUIPMENT

OPR: HQ AFSC/SEGO
(Richard L. Baird)
Supersedes AFOSH Standard 127-46,
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Certified by: HQ AFSC/SEG
(Colonel John P. Lucas)
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The criteria in this standard are the Air Force's minimum safety, fire protection, and occupational health requirements. Major commands (MAJCOM), direct reporting units (DRU), and field operating agencies (FOA) may supplement this standard when additional or more stringent safety, fire prevention, and health criteria are required. Refer to Air Force Instruction (AFI) 91-301 (formerly designated AFR 127-12), *Air Force Occupational and Environmental Safety, Fire Protection, and Health (AFOSH) Program,* for instructions on processing supplements or variances. Report conflicts in guidance between this standard, federal standards, or other Air Force directives through MAJCOM, DRU, or FOA ground safety offices to Headquarters Air Force Safety Center, Ground Safety Division, Safety Engineering and Standards Branch (HQ AFSC/SEGS), 9700 G Avenue, SE, Suite 222D, Kirtland AFB NM 87117-5670.

This standard establishes Air Force safety criteria for manual and powered materials handling requirements. It implements portions of Occupational Safety and Health Administration (OSHA) Standard 29 Code of Federal Regulations (CFR) Part N, *Materials Handling and Storage*,and includes additional requirements not addressed by the OSHA standard. The Air Force single point of contact to certify equipment for use with nuclear weapons is HQ AFSC Nuclear Systems Engineering Division (SEWA), 9700 G Avenue, SE, Suite 120, Kirtland AFB NM 87117-5670. This office, in coordination with the San Antonio Air Logistics Command Directorate of Nuclear Weapons (SA-ALC/NWTD), 413 North Luke Drive, Building 1420, Kelly AFB TX 78241-5314, establishes the equipment as certified and ensures the equipment is listed in Technical Order (TO) 00-110N-16, *USAF Nuclear-Certified Equipment and Software.*

This standard applies to all US Air Force organizations, including US Air Force Reserve personnel and when Air National Guard personnel are on Federal Service.

SUMMARY OF REVISIONS

This revision implements regulatory federal requirements. It adds training requirements for powered industrial trucks operators (paragraphs **3.2.4.4.**, **3.2.6.5.14.**, and **3.2.4.6.15.**) and certification records of inspections of hooks and hoist chains (paragraphs **5.2.5.1.4.**, **5.2.5.1.5.**, and **9.2.1.4.**); changes the frequency of periodic inspection requirements (paragraphs **5.2.5.2.** and **7.2.5.7.2.**); modifies physical qualifications of operators and the requirements for annual physical examinations are revised (paragraphs

5.2.3.1.); deletes Chapter 12, *Operations Using Nuclear Certified Hoists, Overhead Gantries, or Monorails*, and moves required guidance for nuclear certified equipment to the main text; and adds a glossary of definitions, references, abbreviations, acronyms, and terms (**Attachment 1**). A | indicates revisions from previous edition of AFOSH Standard 127-46.

The use of illustrations in the standard are to aid in recognition of equipment only and does not imply endorsement by the Air Force. ***NOTE:*** AFRs are now Air Force Policy Directives (AFPD), AFIs, and (or) AF Pamphlets (AFPAM). In addition, AF Manuals (AFM) are changing to AFMAN. AFOSH 127-series standards are changing to 91-series (when revised) and 161-series standards will become 48-series. When known, the new number of each AFPD, AFI, AFPAM, AFMAN, and AFOSH standard is provided, along with a reference to the previous number.

Chapter 1

MANUAL MATERIAL HANDLING

1.1. Hazards and (or) Human Factors. Strains, sprains, hernias, fractures, and bruises are the common injuries associated with manual materials handling. Lifting, carrying, dropping, and lowering are the common physical acts responsible for these injuries. Sprains account for approximately 30 percent of the lost time injuries in the Air Force. Many of the strains are the direct result of improper lifting techniques, lifting with no assistance, or failure to use required and available material handling equipment.

1.1.1. Individual Variables. There are several variables which influence the ability of people to manually handle materials:

1.1.1.1. Physical. Age, sex, strength, mobility, fatigue, and motor functions.

1.1.1.2. Psychological. Motivation, emotional status, job satisfaction, and attitude toward work.

1.1.1.3. Pre-existing Injury.

1.1.2. Task Variables:

1.1.2.1. Load Handled. Weight, size, shape, distribution of the load, ease or difficulty of coupling, degree of shift of the load in the container, and the location of the center of gravity (CG).

1.1.2.2. Workplace Layout. Degree of movement required, obstacles, distances moved, and direction of movement.

1.1.2.3. Level of Demand. Frequency of lift, duration of lifting tasks, accelerations and velocities of lift, shift duration, degree of precision, and relative proportion of muscles involved in the lifting.

1.1.3. Environmental Variable. Heat and cold stress, noise and vibration, lighting, toxic agents, traction, stability of the work platform, and atmospheric contaminants.

1.2. Requirements. No single technique for preventing injury during lifting and material handling has been discovered despite numerous research efforts. The best prevention strategy is to ensure workstations are properly designed, loads are manageable in both size and weight distribution, the frequency and duration of lifting are not excessively stressful, and workers can demonstrate a knowledge of proper techniques for material handling.

1.2.1. Training. The training program should be developed and presented by the supervisor and be designed to provide the worker a general awareness of ergonomic principles including:

- procedures for performing routine or high risk manual handling activities;
- the importance of seeking ways to improve the methods used in accomplishing the work and eliminate manual material handling hazards; and
- an understanding of the stresses involved during manual handling which cause injuries.

This training should include both verbal and written materials that explain how to do the task correctly with practice and proper motions.

1.2.1.1. Supervisors must train personnel who are required to regularly perform manual lifting. Training will be documented on the AF Form 55, **Employee Safety and Health Record,** or other

authorized methods (refer to AFI 91-301). Information to assist the supervisor in establishing a program is located in this chapter and additional materials may also be found in the National Safety Council (NSC) **Accident Prevention Manual for Industrial Operations, Engineering, and Technology.** When necessary, the supervisor may contact the installation ground safety staff for assistance in developing the program and to review the NSC publication.

1.2.1.2. The supervisor shall consider having personnel evaluated for physical fitness for duty when job task requires continuous manual lifting. When required, physical profile changes will be evaluated for possible reassignment actions to prevent recurring injuries to personnel.

1.2.2. Lifting Methods. There are three basic methods of lifting, that is, straight back-bent knees, free style, and kinetic. Each has advantages and limitations. The kinetic method is the most widely accepted and taught because it provides more stability for the worker while reducing load on the back muscles and intervertebral disks. Instructions how to lift properly follow:

1.2.2.1. Position feet correctly. Place feet far enough apart for balance with one foot to the rear of the object and the other foot slightly ahead of the other and to the side of the object (refer to **Figure 1.1.**).

1.2.2.2. Crouch close to the load (refer to **Figure 1.1.**). Stay close to the load to minimize strain on the lower back. Before beginning the lift, be sure the back is straight as possible and back muscles are tightened. These steps prepare the body to accept the load.

1.2.2.3. Pick up materials with a full palm grip. Do not attempt to pick up weights with a fingertip grip. Ensure the load is free of grease or sharp points which could cause injury. Use suitable gloves when necessary.

1.2.2.4. Always keep the back as straight as possible (refer to **Figure 1.1.**). It may not be possible to keep the back in the vertical plane but avoid arching the back. Keep the back muscles tightened throughout the duration of the lift. Do not relax the back until the load is released. Bend from the hips and not from the middle of the back.

1.2.2.5. With the arms, slide the object toward the body to give it some motion (kinetic energy). At the same time, use the legs to lift the object and bring the back to a vertical position. Keep the object close to the body while lifting (refer to **Figure 1.1.**).

1.2.3. Team Lifting. When required to manually move heavy or unusually shaped items, always seek and obtain assistance. When two or more people are required to move or carry an object, adjust the load so each person carries an equal part. Test lifts should be made before proceeding. The key to lifts using two or more personnel is to make every move in unison. The supervisor and workers are responsible for assessing all available methods to safely handle materials described above and use mechanical assistance whenever possible.

1.2.4. Carrying Methods. Acceptable carrying methods differ, based upon the type of material, distance, and number of workers. Workers should be instructed during initial training in each procedure (for example, neck, shoulder, side, tray, two-person, and under-arm carry methods, etc.). Some points to remember are:

1.2.4.1. Use gloves to protect the hands and safety shoes to protect the feet.

1.2.4.2. Inspect objects for slivers, sharp edges, and rough or slippery surfaces before attempting to lift.

1.2.4.3. Keep fingers away from pinch and shear points.

1.2.4.4. Do not carry a load that obstructs the view of the direction of travel. Make sure that the path of travel is clear.

1.2.4.5. Do not turn at the waist to change direction or to put an object down. Turn the whole body and crouch down to lower the object.

1.2.4.6. When carrying items up or down stairways:

1.2.4.6.1. Adhere to the guidance provided by the supervisor.

1.2.4.6.2. Try to reduce the bulk or size of the object carried to allow for maximum visibility.

1.2.4.6.3. Use assistance when required and available.

1.2.5. Minimizing Manual Material Handling Hazards:

1.2.5.1. Engineering Controls. When other methods are not practical, consider using engineering controls such as employing mechanical assists to decrease the force, the repetition, distance of travel, and frequency of the manual handling activities. Some examples include scissor tables, levelators, conveyors, and gravity chutes.

1.2.5.2. Administrative Controls. Job rotation schedules and mandatory work-rest cycles can be useful to reduce hazards, but do not eliminate the hazard and are not as reliable as engineering controls.

1.2.5.3. Work Design Principles. Conduct a job safety analysis, identify potential hazards, and when practical, arrange tasks and select workstations using the following principles:

1.2.5.3.1. Place objects to be lifted at the approximate height of the knuckles when the arms dangle at side of the body.

1.2.5.3.2. Limit stack height to shoulder level. If items must be stacked higher, provide step-up access to eliminate lifting above shoulder level.

1.2.5.3.3. Use grips, handles, and other devices to provide better control of items.

1.2.5.3.4. Slide materials instead of lifting, whenever possible.

1.2.5.3.5. Use gravity assist in moving materials.

1.2.5.3.6. Ensure adequate maneuvering space to eliminate the need to twist the body.

1.2.5.3.7. Consider team lifting when items are known to weigh more than 25 pounds.

1.2.6. Hand Tools. Hand tools are discussed in detail in TO 32-1-101, Use and Care of Hand Tools. All personnel will be instructed in and will use the appropriate tools for each job. Examples: nail pullers will be used for opening boxes, strap or wire cutters for cutting strapping or wire, etc.

1.2.7. Inspection. Prior to movement, material will be examined for sharp edges, protruding points, and weak places. When defects cannot be corrected, additional steps will be taken to protect the worker. This should be accomplished by isolating the unsafe condition, for example, using an enclosed cart when moving sheetmetal scraps.

1.2.8. Personal Protective Equipment (PPE). Supervisors will conduct a job safety analysis (JSA) to evaluate each task and identify the need for PPE such as safety-toed shoes, gloves, and eye protec-

tion. The installation ground safety staff and the bioenvironmental engineer (BE) are available to assist in this evaluation process. AFOSH Standard 91-31 (formerly designated AFOSH Standard 127-31), Personal Protective Equipment, Department of Defense (DoD) 4145.19-R-1, Storage and Materials Handling, and AFMAN 23-210, Joint Service Manual (JSM) for Storage and Materials Handling, should be consulted when selecting PPE. ***Note: The BE will certify the applicability of chemical protective equipment, respirators, or other health-related PPE.***

1.2.8.1. All personnel directly involved in the handling of supplies or material will wear approved safety shoes.

1.2.8.2. Personnel will wear leather workman's gloves when manually handling objects that have sharp or burred edges or splintered surfaces.

1.2.8.3. Personnel will wear appropriate ear protection when working in or visiting hazardous noise areas.

1.2.8.4. Personnel will carry tools that have sharp edges in protective holders, not unshielded in pockets.

1.2.8.5. Personnel will wear appropriate protective clothing when transporting, delivering, or working with hazardous materials.

1.2.8.6. Material handlers will not wear finger rings, jewelry, or loose clothing and will keep long hair completely covered when around moving conveyor belts, open rotating shafts, or other moving parts of machinery.

1.2.8.7. Personnel will wear goggles and (or) safety spectacles with side shields and gloves when cutting strapping. Personnel will stand out of the way so cut strapping does not contact them. A board or other hold-down device may be used to prevent the strapping from flying out from the material.

1.2.9. Other Safety Requirements:

1.2.9.1. Stack all materials neatly, arrange them in an orderly manner, and limit the stack height to minimize the chances they will fall.

1.2.9.2. Remove, repair, or replace defective or broken strapping on material.

1.2.9.3. Except when using approved chutes, do not throw materials from elevated places. Carry or lower them.

1.2.9.4. If materials handling equipment (MHE) is not available and drums must be manually moved; roll drums by pushing with the hands, not the feet. Ensure a minimum of two people upend them.

1.2.9.5. If at all possible, carry broken glass in a container other than a plastic bag or enclose the broken piece in cardboard or protective shield before placing in a bag. This will reduce the possibility of cuts from glass protruding from bags.

1.2.9.6. Do not run when carrying materials.

1.2.9.7. When unpacking materials, follow good housekeeping rules; for example, discard banding, packing materials, and empty cartons properly.

1.2.10. Two-Wheeled Handtrucks and Wheelbarrows. Two-wheeled handtrucks and wheelbarrows are designed in a variety of shapes and sizes for both general and special purposes. Preference will be given to procuring handtrucks and wheelbarrows equipped with knuckle guards. Supervisors will instruct workers in their use. To the new worker, handtrucks and wheelbarrows look deceptively easy to use. However, mishaps occur because basic safe procedures are not followed.

1.2.10.1. Material should be tipped slightly forward so the tongue of the handtruck will go under the load.

1.2.10.2. The center of gravity of the load on both the handtruck and wheelbarrow will be kept as low as possible. The weight should be forward so it will be carried by the axle, not the handles. If loaded correctly, the handtruck and wheelbarrow should carry the load — the operator need only balance and push.

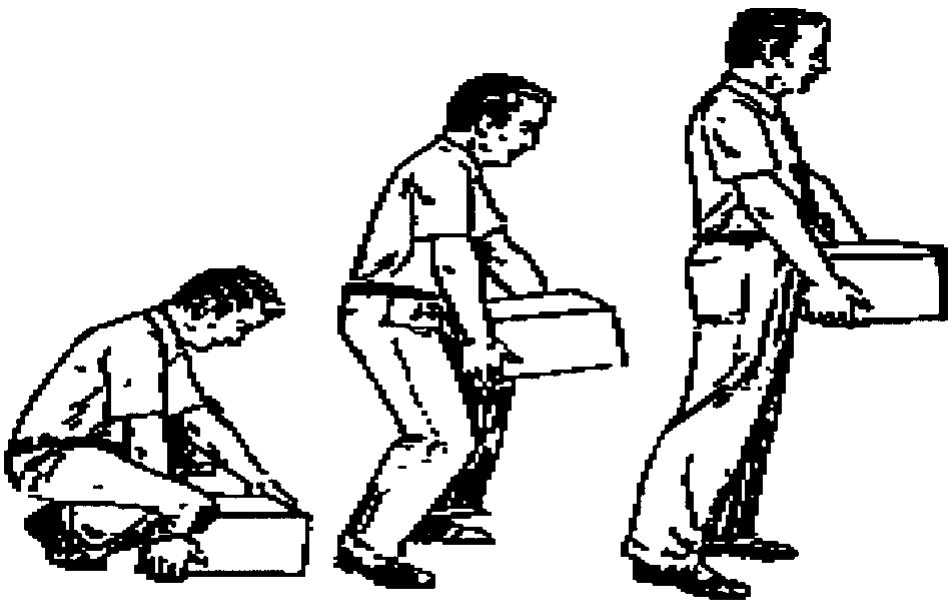
1.2.10.3. When a handtruck is loaded in a horizontal position, proper lifting procedures discussed in paragraph **1.2.2.** will be used to prevent operator injury.

1.2.10.4. Loads will be positioned to prevent shifting or falling. Bulky or hazardous items (such as cylinders or drums) shall be secured. Additionally, material shall not be positioned so it obstructs the worker's view.

1.2.10.5. Handtrucks should be pushed, not pulled, after initially positioned for movement.

1.2.11. Multi-Wheel Trucks. As with two-wheeled equipment, multi-wheeled trucks and dollies vary greatly in design and use. Most mishaps occur due to improper parking causing the worker to fall over the equipment or improper loading of material which causes the cart to tip. Extra emphasis will be placed on worker training in these two areas, along with frequent observation of work practices to immediately correct unsafe acts.

Figure 1.1. How to Lift Properly.



Chapter 2

MANUAL HOISTING AND (OR) PULLING DEVICES

2.1. Hazards and (or) Human Factors. Some common hazards associated with lever-operated hoists can be attributed to misuse due to the use of extensions (cheater bars) and indirect pulls. Injury can also be caused by the lack of proper storage and maintenance procedures.

2.2. Requirements:

2.2.1. Acquisition. Lever-operated hoists shall meet the requirements and specifications of recognized industry standards.

2.2.1.1. Capacity of all lever-operated devices shall be permanently and conspicuously marked in an easily visible place on the hoist.

2.2.1.2. Only ratchet and pawl and load brake hoists, which include a means to prevent a suspended load from self-lowering, will be procured. Lowering under load shall be by operation of the hoist lever.

2.2.2. Inspections:

2.2.2.1. Daily or prior to each use, lever-operated hoists shall be inspected for:

2.2.2.1.1. Loose or worn parts, nuts, bolts, etc.;

2.2.2.1.2. Cracked or broken welds or parts;

2.2.2.1.3. Deformed or damaged hooks (see paragraph **5.2.5.1.5.**);

2.2.2.1.4. Bent or deformed pawls; and

2.2.2.1.5. Lubrication.

2.2.2.2. Annual inspection shall include:

2.2.2.2.1. Complete inspection of all wire rope, chain, and fittings or attachments.

2.2.2.2.2. Inspection of brakes, pawls, or other holding features.

2.2.2.2.3. Inspection of the chain length. Chains that have elongated more than one fourth of an inch in 12 inches shall be removed from service.

2.2.2.3. Identification tags shall be attached to all hoists. Tags shall include the following information:

2.2.2.3.1. Date of inspection;

2.2.2.3.2. Date of proof test;

2.2.2.3.3. Capacity of hoist; and

2.2.2.3.4. Identification number of hoist.

2.2.3. Maintenance and Testing:

2.2.3.1. All hoists which have had load sustaining parts altered, replaced, or repaired will be proof-load tested before use by the owning activity. All new hoists will have the manufacturer's

certification that all proof-load testing has been accomplished. These tests will be 125 percent of the rated capacity. A record of all tests will be maintained by the user.

2.2.3.2. Maintenance will be performed according to the manufacturer's instruction or applicable TO.

2.2.4. Safe Operations:

2.2.4.1. Lever-operated hoists shall only be used in a direct pull. Where indirect pulls are permitted by design of the hoist, a sheave or pulley of adequate size shall be used.

2.2.4.2. Hoist cables, ropes, and chain shall not be wrapped around the load. Use only slings or other approved lifting fixtures. For example: cargo straps shall not be used for lifting, unless stated in approved Air Force technical data or TOs. (Refer to **Chapter 6** for information on slings.)

2.2.4.3. Positive action safety latches shall be installed on all hooks.

2.2.4.4. Hooks shall not be point loaded unless designed for this purpose. All loads shall be seated in the saddle of the hook.

2.2.4.5. Extensions to levers (cheater bars or pipes) shall not be used to increase leverage. Extendible levers designed and permanently installed by the manufacturer are authorized.

2.2.4.6. Manually operated lever hoists shall only be operated by personnel familiar with the use of the equipment. Operator qualifications will be as determined by the facility and (or) shop supervisor or designated representative.

2.2.4.7. The rated load shall not be exceeded except for authorized proof tests.

2.2.4.8. Hoists shall be attached to well defined dead-end points capable of withstanding the intended load. ***Note: Lifeline attach points shall not be used for hoists.***

Chapter 3

POWERED INDUSTRIAL TRUCKS

3.1. Hazards and (or) Human Factors. Mechanical assistance ranges from simple hand trucks to complex powered forklift trucks. The type of mishaps include dropped property, bruises, head injuries, cuts, and lacerations to personnel, and fatalities due to turn-overs. Following are several common operator errors associated with the operation of powered industrial trucks:

3.1.1. Jerky starts and stops.

3.1.2. Failure to give proper signals when turning.

3.1.3. Traveling too fast and turning too sharply.

3.1.4. Failure to sound horn at intersections or when entering or exiting a building.

3.1.5. Turning too wide on corners.

3.1.6. Cutting corners too sharply.

3.1.7. Forklift trucks carrying loads too high when traveling. (Tines should not be higher than 6 inches above the surface.)

3.1.8. Lowering loads too fast.

3.1.9. Failure to ensure that a pallet load is properly balanced and stacked.

3.1.10. Failure to ensure that forks (tines) are fully under the load before lifting.

3.1.11. Striking the pallet or the floor with the forks.

3.1.12. Driving across bridge plates too fast and failure to observe load carrying capacity on bridge plates.

3.1.13. Positioning empty forks too high when traveling (no higher than 6 inches above the surface).

3.1.14. Failure to release parking brake before traveling.

3.1.15. Driving forward when vision is restricted by the load.

3.2. General Requirements:

3.2.1. Acquisition. Commercially procured materials handling and lifting equipment or parts will conform to the specifications outlined in 29 CFR 1910.176, Handling Materials--General, 1910.177, Servicing Multi-Piece and Single Piece Rim Wheels, 1910.178, Powered Industrial Trucks, American National Standards Institute (ANSI) B56-1, Low Lift and High Lift Trucks; and National Fire Protection Association (NFPA) 505, Industrial Trucks, Powered. Local modifications of centrally procured materials handling equipment will be done only with the approval of the equipment item managers. Local purchase acquisition requests should be coordinated with the installation ground safety staff. (Refer to **Figure 3.1.** through **Figure 3.16.** for examples of materials handling and lifting equipment.)

3.2.2. Inspection. All materials handling and lifting equipment will be inspected prior to use by the operator. Equipment will be kept clean. When inspecting equipment, operators will use AF Form 1806, **Operator's Inspection Guide and Trouble Report,** for industrial tractors and (or) tugs and AF Form 1810, **Operator's Monthly Report,** for forklifts. Equipment with safety defects will be imme-

diately removed from service until such defects are corrected. (Examples of safety defects are: malfunctioning brakes, steering mechanisms, control mechanisms, warning devices, lights, lifting mechanisms, guards or tilt mechanisms, fuel leaks, worn or damaged tires, or damaged exhaust systems.)

3.2.3. Maintenance:

3.2.3.1. Repairs to the fuel, electrical, or ignition systems will be accomplished by qualified personnel only in locations approved for such repairs. Deviations to this requirement will be approved by the installation fire chief through coordination with the responsible ground safety manager.

3.2.3.2. Equipment will be cleaned in designated locations and only with cleaning agents approved by fire and BE personnel.

3.2.4. Training:

3.2.4.1. Each activity requiring training on powered materials handling and lifting equipment will designate qualified personnel as instructors to train and supervise the operator trainee. The names and grades of instructors will be forwarded to the vehicle operations officer who will thoroughly screen each for background and experience in the type of equipment of which instruction will be given. A list of approved instructors will be retained on file by the using activity and the vehicle operations activity.

3.2.4.2. Training outlines for each piece of equipment will be accomplished by the unit according to instructions in AFI 24-301 (formerly designated AFM 77-310 Volume 1), Vehicle Operations. The training outline (course content) will include a written examination to evaluate the operator's knowledge of equipment operations and service instructions. AFM 52-4, Special Purpose Vehicle Training Manual, may aid in development of lesson plans for some types of equipment.

3.2.4.3. The instructor will furnish the vehicle operations officer with written certification, along with examination results, prior to certification of an operator's qualification to operate equipment on the AF Form 171, **Request for Driver's Training and Addition to U. S. Government Motor Vehicle Driver's License.**

3.2.4.4. In addition to initial training and certification, a qualified instructor shall evaluate each operator annually and provide refresher or remedial training when there is reason to believe there is a need; such as a near miss, a reportable mishap, or if the annual evaluation indicates that an operator is not capable of performing assigned duties.

3.2.4.5. The base or unit explosives and (or) weapons safety manager will review course outlines to support the training of materials handling equipment operators according to requirements in AFI 91-202 (formerly designated AFR 127-2), The US Air Force Mishap Prevention Program, and will monitor the explosives phase of the training through spot checks.

3.2.4.6. Materials handling and lifting equipment training will include:

3.2.4.6.1. Equipment design, to include restrictions, limitations, and hazards relative to the environment where used.

3.2.4.6.2. Operating and maintenance instructions, including those contained in this standard.

3.2.4.6.3. Safe loading and (or) unloading requirements.

3.2.4.6.4. Operating techniques inside and outside of warehouses.

3.2.4.6.5. Flight line rules and (or) regulations (when applicable).

3.2.4.6.6. Fire extinguisher training which will be accomplished annually after initial instructions.

3.2.4.6.7. Use of attachments such as extended forks or tines or personnel lift pallets.

3.2.4.6.8. Clearances, heights, and limitations.

3.2.4.6.9. Safety clothing and equipment.

3.2.4.6.10. Fire protection (fuel spills, maintenance of equipment, smoking, etc.).

3.2.4.6.11. Operating restrictions in relation to potentially hazardous storage areas (flammable, toxic, lumber, coal, etc.).

3.2.4.6.12. Computing inch-pound rating of loads and equipment.

3.2.4.6.13. Damage that may be caused by acid or caustic material.

3.2.4.6.14. Workplace related topics such as surface conditions, local policies on stacking, unstacking, and load manipulation.

3.2.4.6.15. Applicable information contained in paragraphs **3.2.4.6.**, 3.2.4.7., and **3.3.**

3.2.5. Safeguarding Requirements:

3.2.5.1. All materials lifting equipment powered by internal combustion engines will be equipped with fire extinguishers. Type, size, and location will be determined by the local fire chief. AFMAN 91-201, Explosives Safety Standards, has requirements for explosives operations.

3.2.5.2. The maximum capacity load will be posted on each piece of lifting equipment, in view of the operator, and will be kept current to reflect changes. Any modifications or added attachments will be approved and load capacity posted on the items.

3.2.5.3. All high-lift equipment will be equipped and operated with overhead guards to protect the operator from falling objects. The overhead guards will not be covered with material that could obstruct the operator's vision.

3.2.5.4. Where steering must be accomplished with one hand and a steering handwheel is used, steering knobs (or equivalent) may be used for safe and effective operation. The steering knob will not protrude beyond the outside periphery of the handwheel.

3.2.5.5. Load backrest extensions will be used whenever necessary to minimize the possibility of the load falling rearward.

3.2.5.6. When a forklift is used to elevate personnel, an approved safety pallet, as illustrated in **Figure 3.1.**, will be used. It will be equipped with the features identified in the figure.

3.2.5.7. The operator will remain at the controls at all times when personnel are on the safety platform, but will not move the forklift.

3.2.5.8. Instructions prohibiting the movement of the forklift with personnel on the safety pallet should be posted on the pallet.

3.2.6. Safe Operation Requirements:

3.2.6.1. Battery powered equipment will be used whenever possible. When internal combustion engine equipment is used inside warehouses, ventilation requirements will be determined by the installation BE to preclude exposure of workers to carbon monoxide gas. Refer to AFOSH Standard 48-2 (formerly designated AFOSH Standard 161-2), Industrial Ventilation. See AFMAN 91-201 for operating in explosives and (or) weapons areas.

3.2.6.2. Internal combustion engine equipment will not be warmed up inside a building and will be turned off when not in use.

3.2.6.3. Liquid Petroleum (LP) gas fuel industrial trucks may be used in buildings or structures approved by the installation fire and ground safety officials. If used inside buildings or structures, there will be no more than two 10-gallon fuel containers on the truck and the truck will not be left unattended with the engine running. (Also see paragraph **3.2.6.1.**)

3.2.6.4. Operation of high and (or) low lift trucks (platform, pallet trucks, rider trucks, reach trucks, side loader trucks, picker trucks, straddle lift trucks, etc.):

3.2.6.4.1. Personnel will not be permitted to ride on powered lift equipment unless a passenger seat is provided.

3.2.6.4.2. The operator will not extend any portion of body between the uprights of the mast or outside the running lines of the equipment.

3.2.6.4.3. When leaving powered lifts unattended with the operator's seat vacated, operators will fully lower the forks, neutralize controls, shut power off, and set brakes. They will chock the wheels if the vehicle is parked on an incline. At the close of business each day, LP powered and gasoline operated MHE will be parked on the warehouse ramp, drip pans in place.

3.2.6.4.4. Operators will use caution when traveling on docks or loading platforms and remain clear of the edge.

3.2.6.4.5. Operators will not use forklifts to push or pull objects, such as freight cars, or to open and close freight and warehouse doors. **EXCEPTION:** When side loading vans are not available, munitions containers with permanently installed skids may be pushed or pulled into end-opening vans. Ensure safety precautions, such as keeping personnel clear of potentially hazardous areas, have been considered and included in the procedure.

3.2.6.4.6. Operators will set brakes and dock locks or put wheel chocks in place to prevent any movement of trucks, trailers, or railroad cars while loading or unloading. Fixed jacks will be used to support semitrailers during loading or unloading when the trailer is not coupled to the tractor. The operator will check the flooring of trucks, trailers, and railroad cars for breaks and weakness before driving onto them. Loads will not be transferred across the tailgate when it is supported solely by its chain. The tailgate must be supported by the mating surface across its entire width or a bridgeplate will be used. (Also see paragraph **3.2.6.5.13.**)

3.2.6.4.7. Operators will ensure sufficient head room or clearance under overhead installations, lights, pipes, sprinkler system, etc.

3.2.6.4.8. Personnel will not stand or pass under the elevated portion of a lift whether the lift is loaded or empty.

3.2.6.5. When traveling:

3.2.6.5.1. While operating inside warehouses, operators will observe all established driving procedures and will not exceed 5 miles per hour. Under normal traffic conditions, operators will keep to the right, maintain a safe distance (approximately three truck lengths from the truck ahead), and will keep the truck under control at all times, especially during turns and while traveling over slippery or wet floors and rough surfaces.

3.2.6.5.2. Operators will not pass other vehicles or pedestrians at intersections, blind corners, or at other dangerous locations.

3.2.6.5.3. Operators will slow down and sound the horn at cross aisles, warehouse entrances and exits, or at other dangerous locations where vision is obstructed. Operators will be prepared to stop and will not proceed until the way is clear.

3.2.6.5.4. When loads obstruct the forward view, operators will travel with the load trailing.

3.2.6.5.5. Operators will cross railroad tracks diagonally whenever possible to avoid jarring of the load.

3.2.6.5.6. Operators will not park lifts closer than 8 feet from the center of railroad tracks.

3.2.6.5.7. The operator will look in the direction of travel and keep a clear view.

3.2.6.5.8. When traveling up or down ramps or grades, the operator will drive a loaded lift with the load upgrade. A spotter will be used if the operator's vision is obscured by the load. Unloaded trucks will be operated on all grades with the forks downgrade. Caution will be used on all grades. The load on the forks will be tilted back as far as necessary to clear the road surface.

3.2.6.5.9. The operator will operate the lift at a speed that will permit it to be brought to a stop in a safe manner. Horseplay or stunt driving will not be permitted.

3.2.6.5.10. The operator will not travel with lift forks elevated more than 6 inches above the ground or surface or as necessary to clear any surface projections.

3.2.6.5.11. When operating a mast with tilt capability, the operator will tilt the mast back when transporting loads.

3.2.6.5.12. Operators will make smooth starts, turns, and stops to prevent the load from shifting or the truck from overturning.

3.2.6.5.13. Prior to driving onto dockboards or bridge plates, operators will ensure:

3.2.6.5.13.1. Dockboards and (or) bridgeplates are anchored or equipped with stops at both ends near the edges of the platform of the car or truck, to prevent it from sliding.

3.2.6.5.13.2. Dockboards and (or) bridgeplates are strong enough to carry the load.

3.2.6.5.13.3. Dockboards and (or) bridgeplates have handholds or other effective means to permit safe handling.

3.2.6.5.13.4. Dockboards and (or) bridgeplates are of proper width and (or) length and contain a nonskid surface.

3.2.6.5.14. Operators will approach elevators slowly and enter squarely after the elevator car is properly level. Once on the elevator, the operator will neutralize the controls, shut off the power, and set the brakes.

3.2.6.5.15. Motorized hand trucks will enter elevators or other confined areas with the load end first.

3.2.6.6. When loading:

3.2.6.6.1. The operator will ensure that only stable or safely arranged loads are transported.

3.2.6.6.2. The operator will not exceed the rated capacity of the lift.

3.2.6.6.3. When attachments are used, the operator will take extra care in securing, manipulating, positioning, and transporting the load.

3.2.6.6.4. The operator will use extreme care when tilting loads forward or backward, particularly when high tiering. The operator will not tilt equipment forward with a fork's engaging means elevated, except to pick up a load. An elevated load will not be tilted forward except when the load is in a deposit position over a rack or stack. When stacking or tiering, operators will only use enough backward tilt to stabilize the load.

3.2.6.6.5. The operator will not use more than the manufacturer's specified counterweight system to increase lifting capacity.

3.2.6.6.6. The operator will not align, bump, or push stacks with a lift.

3.2.6.7. When operating warehouse tractor (tug)-trailer trains:

3.2.6.7.1. Tractor operators will obey all traffic regulations and will not exceed 15 miles per hour when towing trailers. When traveling on base roads, trains will keep to the extreme right and if operated at night or in periods of low visibility, lights will be used. The towing of aircraft engines will be according to TO 00-85-20, Engine Shipping Instruction, Chapter 4.

3.2.6.7.2. The operator will not permit passengers to ride on tractors unless adequate seats have been installed.

3.2.6.7.3. Operators will tow no more than four loaded or empty trailers with a tractor or tug. (**EXCEPTION:** Six A/M326 palletized cargo trailers may be towed behind one tractor.)

3.2.6.7.4. To avoid jackknifing trailer trains, the operator will ensure that the train is arranged with the most heavily loaded trailer next to the towing vehicle, the next heaviest second in line, and so on.

3.2.6.7.5. The operator will make sure the couplings are secure before moving a trailer or train. Pintle assemblies and towing connections will be secured with a pintle hook safety pin that will positively lock towing connections.

3.2.6.7.6. The operator will ensure that loads placed on the trailer directly behind the towing tractor are not stacked so high that they prevent or obstruct the operator's view of the remaining trailers.

3.2.6.7.7. Operators will reduce speeds on unlevel roadways to reduce jarring of material.

3.2.6.7.8. When operating a straddle-lift truck operators will:

3.2.6.7.8.1. Ensure that all loads placed on trucks are blocked sufficiently to prevent any part of the cargo from coming in contact with the surface over which the cargo is transported;

3.2.6.7.8.2. Use extreme caution any time the vehicle is being operated in congested areas;

3.2.6.7.8.3. Carry hoist shoes in the up position to avoid striking any obstruction when the truck is not loaded;

3.2.6.7.8.4. Operate vehicles on solid ground at all times;

3.2.6.7.8.5. Avoid sudden stops especially when the truck is loaded;

3.2.6.7.8.6. Ensure all guards and safety devices are in proper repair at all times; and

3.2.6.7.8.7. Ensure straddle trucks, operated on base roads at night or in periods of low visibility, are equipped with head- and tail-lights.

3.2.6.8. Operators who load and unload aircraft using materials handling and lifting equipment will ensure the instructions in TO 36-M-1-141 463L, Material Handling Equipment Systems, applicable aircraft Dash 9, and the following are complied with:

3.2.6.8.1. Ensure the center of gravity of the cargo is as close to the forklift frame as possible, but no further than one-half the length of the tines; raise the load until clear of the surface; and tilt the tines backward prior to transporting.

3.2.6.8.2. When leaving powered lifts unattended, with the operator's seat vacated, fully lower the forks, neutralize the controls, shut the power off, and set the brakes. Chock the wheels if the vehicle is parked on an incline.

3.2.6.8.3. When it is necessary for a K-loader and (or) forklift operator to approach an aircraft in near proximity, use a spotter.

3.2.6.8.4. Do not pitch K-loader cargo platforms forward to aid the on- or off-loading of cargo.

3.2.6.8.5. Ensure that loads on the K-loader are secured by chains forward and aft.

3.2.6.8.6. Secure dunnage to equipment prior to transport.

3.2.6.8.7. Never leave cargo loading equipment on the ramps or taxiways where it will be a hazard to taxied or towed aircraft.

3.2.6.8.8. Do not exceed 5 miles per hour around aircraft and 10 miles per hour on ramps.

3.2.6.8.9. Remove ice or snow from equipment before loading or unloading.

3.2.6.8.10. When cargo loading equipment is left unattended on a flight line, set the hand brake, lower the forks, shut off the ignition, place the transmission in the lowest gear or park if automatic transmission, and chock the vehicle.

3.2.6.8.11. When using hand pallet trucks inside an aircraft, use at least two people.

3.2.6.8.12. Exercise extreme care when using pry bars to move cargo inside an aircraft and be thoroughly familiar with pry bar use limitations and techniques to prevent internal damage to the aircraft.

3.2.6.8.13. Do not allow personnel to position themselves between:

3.2.6.8.13.1. Pallets that are locked in place;

3.2.6.8.13.2. Pallets being loaded and (or) unloaded; or

3.2.6.8.13.3. The moving pallets and the materials handling equipment positioned outside the aircraft when off-loading.

3.2.6.8.14. To prevent damage to pallets or aircraft flooring, check all floor areas prior to loading and (or) unloading to ensure loose items are removed. Immediately report any damages resulting from aircraft loading and (or) unloading to the supervisor.

3.3. Special Requirements:

3.3.1. Material Handling Equipment Parked Inside Warehouses. The decision to park gasoline and (or) diesel powered material handling equipment in general purpose warehouses is the responsibility of the installation commander and shall be approved by local fire and ground safety officials. The following safety operating rules shall be considered:

3.3.1.1. The warehouse is equipped with a fire suppression system or heat sensor devices.

3.3.1.2. Equipment will not block fire aisles, fire fighting equipment, fire alarm boxes, stairways, elevators, or fire exits.

3.3.1.3. An oil absorbent compound is placed under any equipment leaking oil or grease. A metal pan may be used in conjunction with the compound. Corrective actions should be taken to repair leaking equipment.

3.3.1.4. The warehouse supervisor shall conduct inspections daily to ensure that powered materials handling equipment is parked in designated locations, equipment does not contain excessive grease and lint, and gasoline lines, tanks, oil seals, and so forth are not leaking.

3.3.1.5. A minimum of 10-foot clearance shall be maintained between parked equipment and combustible materials.

3.3.1.6. Gasoline or diesel-powered equipment used in multistory buildings shall be parked on the ground floor when not in use. (Also see paragraph **3.2.6.2.**.)

3.3.2. Battery Charging Operations: (See NFPA 505, Section 5-3 for information on charging installation design requirements.)

3.3.2.1. Battery charging operations shall be conducted in adequately ventilated areas that are designated for that purpose.

3.3.2.2. If batteries must be removed from equipment for charging or servicing, a way to flush and neutralize spilled electrolyte and facilities for quick drenching of eyes will be provided. Only trained, qualified equipment operators shall change or charge batteries. If performing service other than removal and replacement of batteries, operators will wear appropriate protective equipment, i.e., rubber apron, face shield, and gloves. Rings, watches, and similar jewelry will not be worn.

3.3.2.3. "No Smoking" signs will be posted in plain view of incoming personnel, to prohibit smoking in the charging area.

3.3.2.4. Tools and other metallic objects will be kept away from the top of uncovered batteries.

3.3.2.5. When charging batteries, the vent caps will be kept in place to avoid electrolyte spray.

3.3.2.6. The battery compartment or covers will be open to dissipate heat. (Also see paragraph **3.2.6.1.**)

3.3.3. Liquid Petroleum (LP) Gas Powered Materials Handling and Lifting Equipment:

3.3.3.1. Operators of LP-gas industrial and lift trucks will not park trucks near sources of heat, open flames, or similar sources of ignition, or near inadequately ventilated pits.

3.3.3.2. Trucks equipped with a permanently mounted container will be refueled outdoors.

3.3.3.3. Exchange of removable fuel containers should be done outdoors. The exchange may be done indoors providing the exchange is made in a well ventilated area away from ignition sources and one of the following methods is used to minimize the release of fuel from the fuel lines:

3.3.3.3.1. Use an approved quick-closing coupling (a type closing in both directions when uncoupled) in the fuel line; or

3.3.3.3.2. Close the shutoff valve at the fuel container and allow the engine to run until the fuel in the line is exhausted. ***Note: Ensure all indoor container change-out operations are approved by local fire protection officials.***

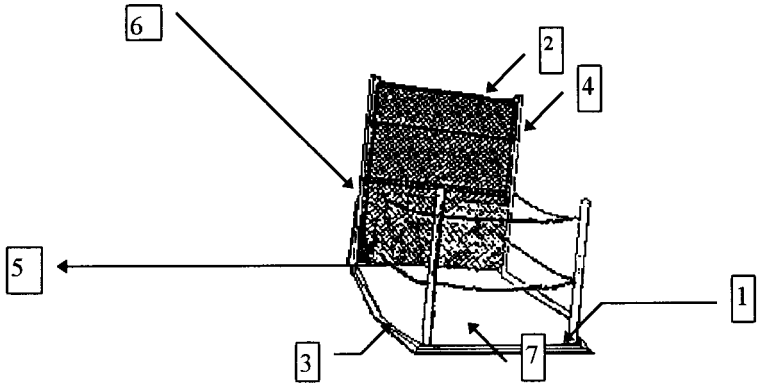
3.3.3.4. Containers will be kept secured at all times. (Also see paragraph **3.2.6.3.**)

3.3.4. Petroleum Equipment Servicing:

3.3.4.1. Units with internal combustion engines will not be refueled inside warehouses or while the engine is running. Refueling will be accomplished in outside areas approved by local fire protection officials.

3.3.4.2. When fuel is spilled during servicing, operations will be stopped and equipment cleaned up according to local procedures prior to restarting fuel servicing operation. The fire protection branch will be contacted if a significant spill is experienced.

Figure 3.1. Approved Safety Pallet.



NOTE: The following correspond to the numbers 1 through 7 positioned around the figure.

1 A 4-inch toeboard to prevent tools or small items from falling off.

2 An expanded metal background to protect personnel from moving parts of forklift.

3 Mitered corners.

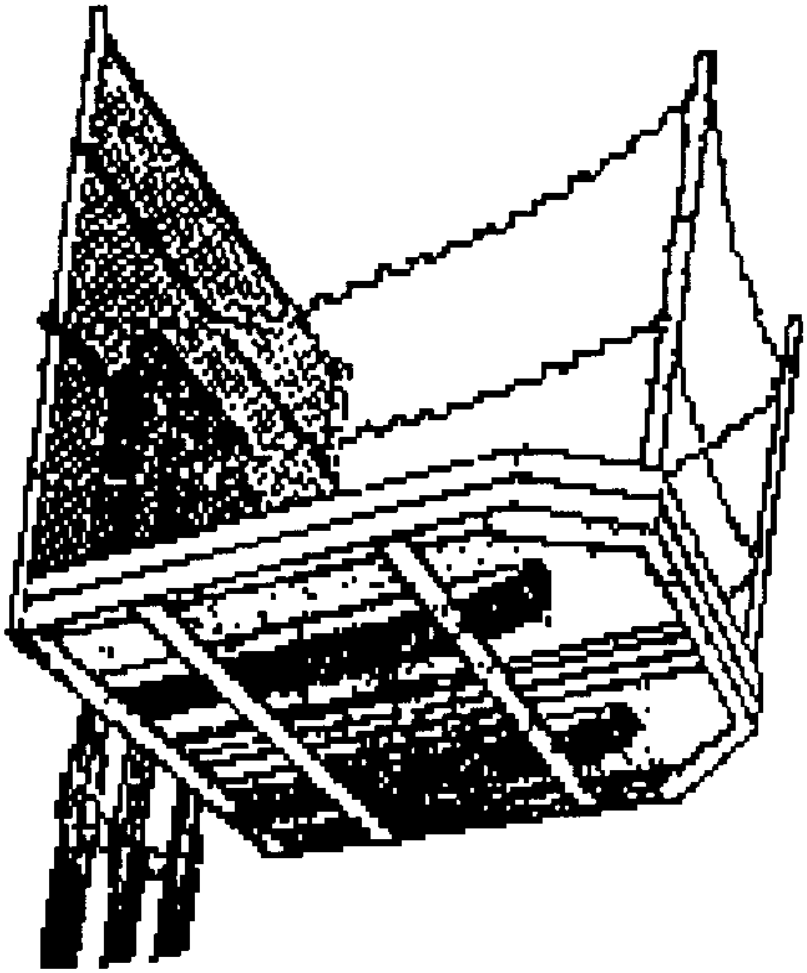
4 Handrail on backguard.

5 Safety chains with the top chain 42 inches from the pallet surface and a second chain approximately midway between the pallet surface and the top chain, to enclose the pallet area.

6 Chains for securing the pallet to the fork truck.

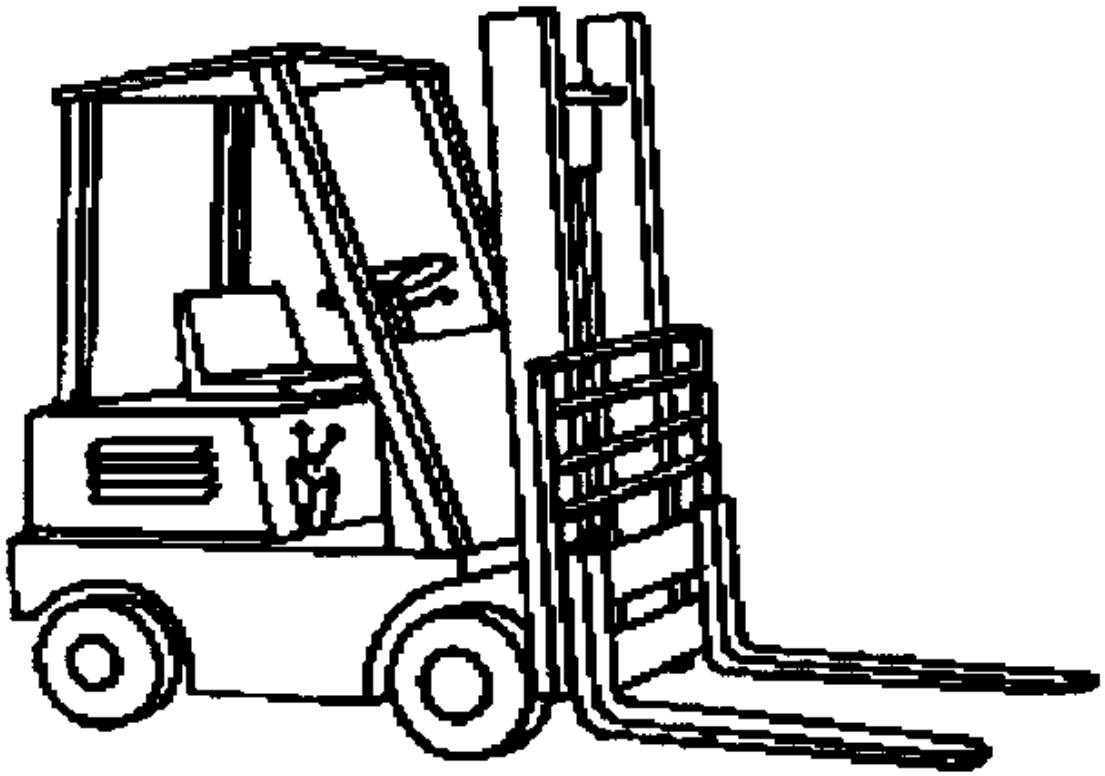
7 Checker plate flooring to prevent slippage of pallet.

Figure 3.2. Extension Forks Used With the Safety Pallet.



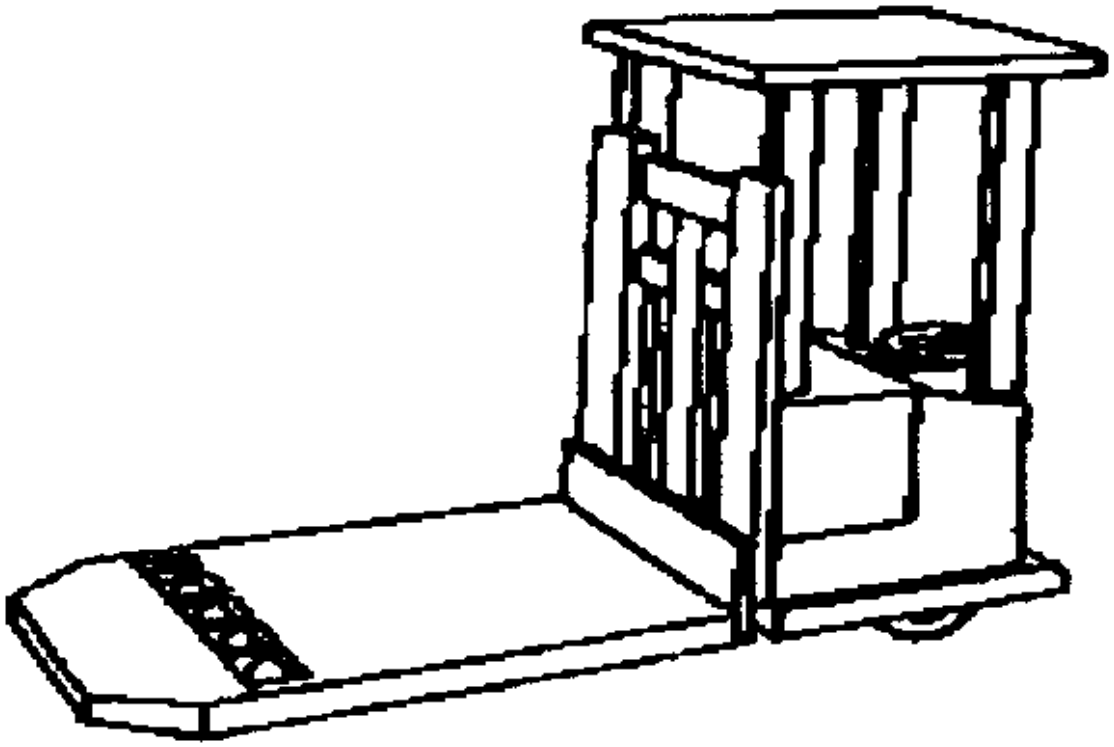
NOTE: **Fork extensions are used to support larger type safety pallets. A notice to this effect will be displayed prominently on the side of the pallet ("Use Fork Extensions").**

Figure 3.3. High-Lift Truck.



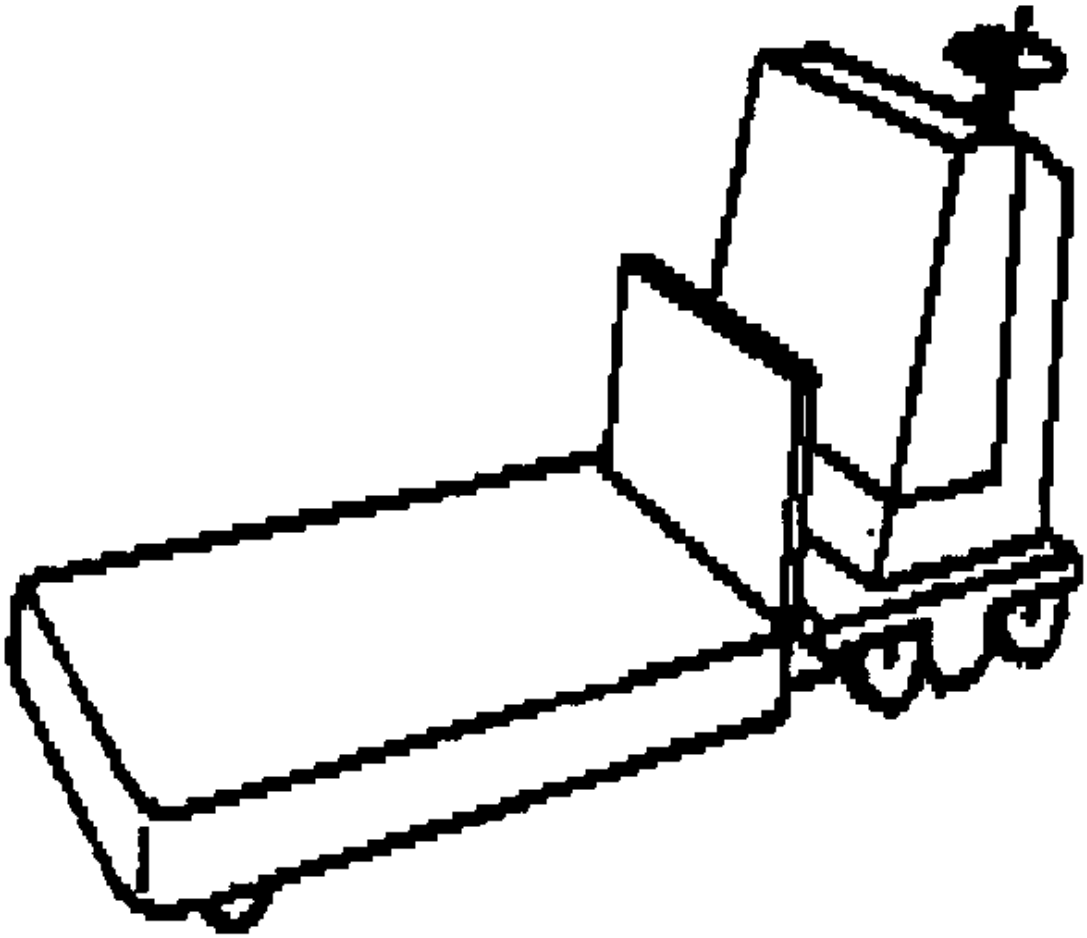
(Also known as Counterbalanced Truck, Cantilever Truck, Rider Truck, or Forklift Truck.)

Figure 3.4. High-Lift Truck.



(Also known as a High-Lift Platform Truck.)

Figure 3.5. Low-Lift Truck.



(Also known as a Low-Lift Platform Truck.)

Figure 3.6. Motorized Hand Truck. (Also known as Pallet Truck.)

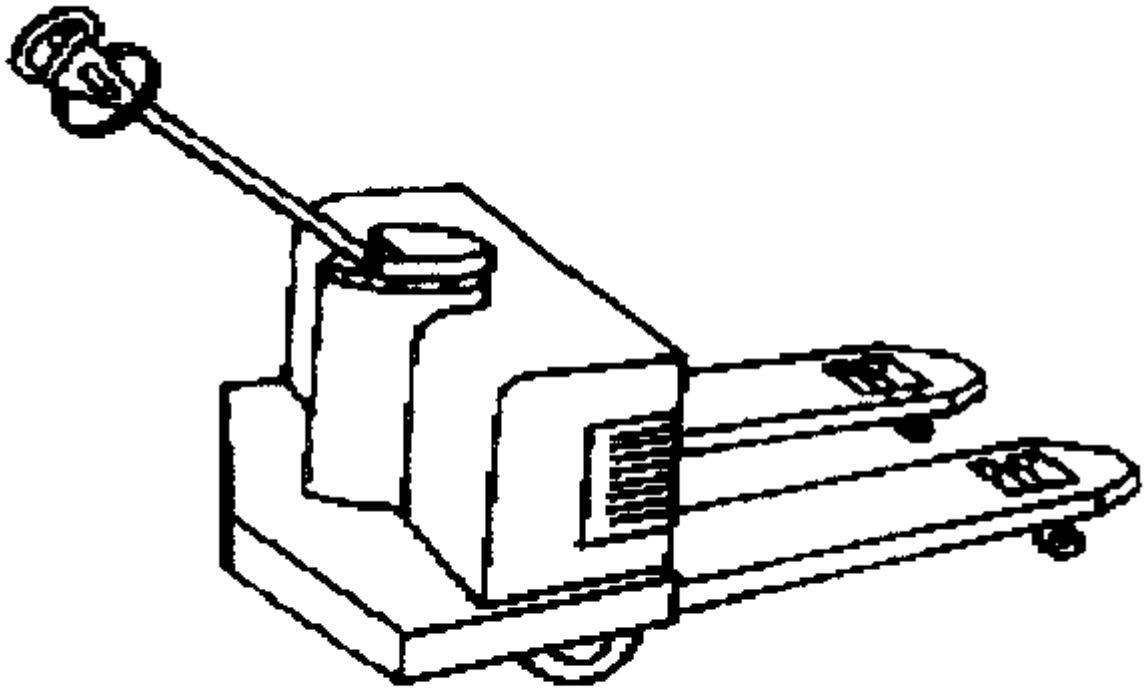


Figure 3.7. Industrial Tractor.

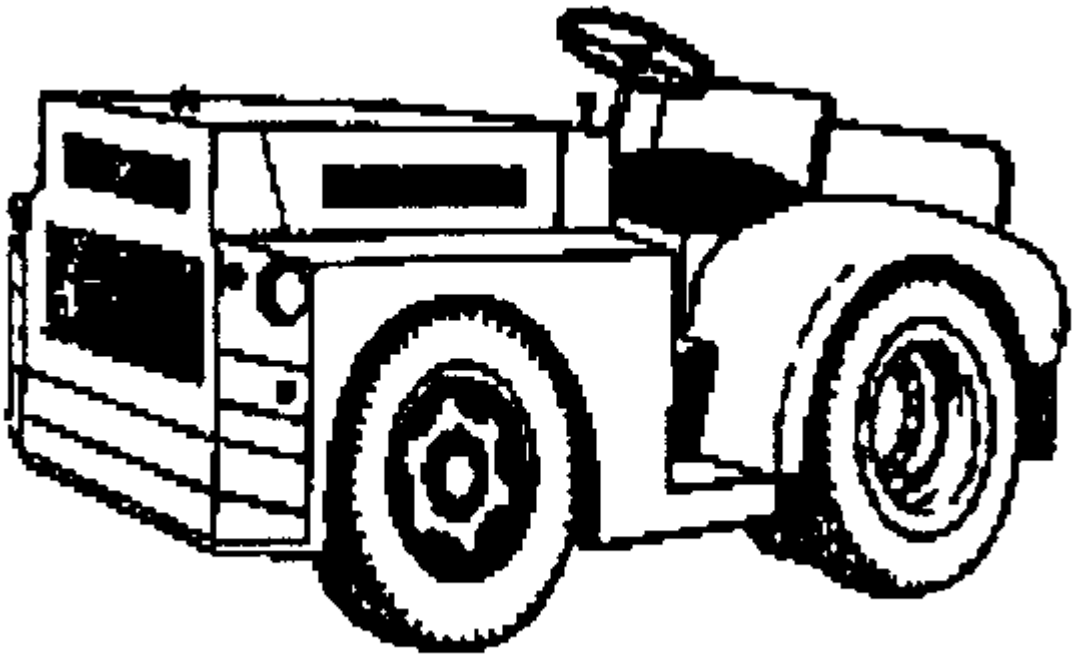


Figure 3.8. Motorized Hand and (or) Rider Truck.

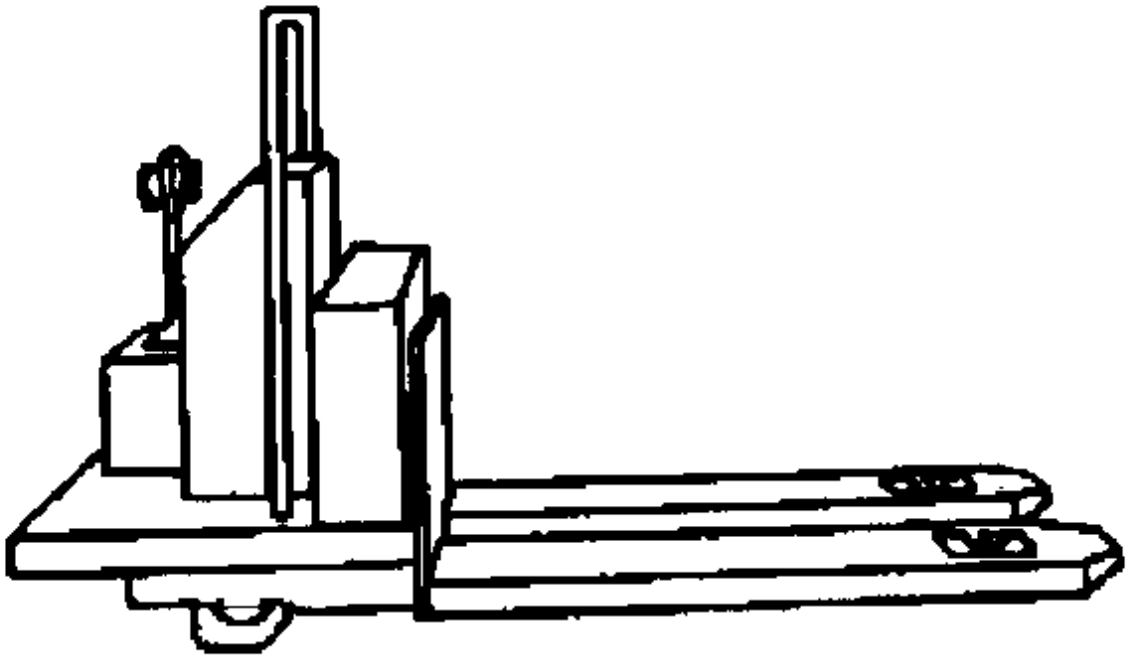


Figure 3.9. Reach Truck.

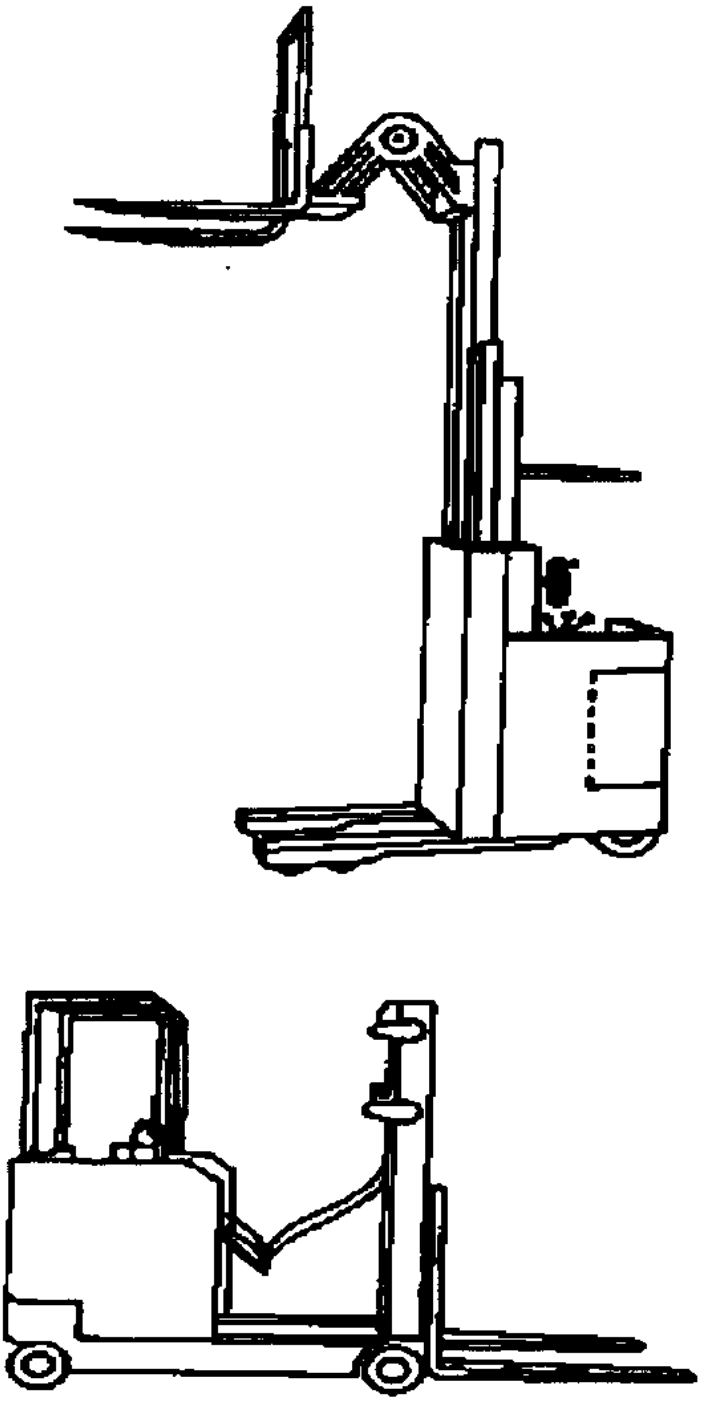


Figure 3.10. Side-Loader Truck.

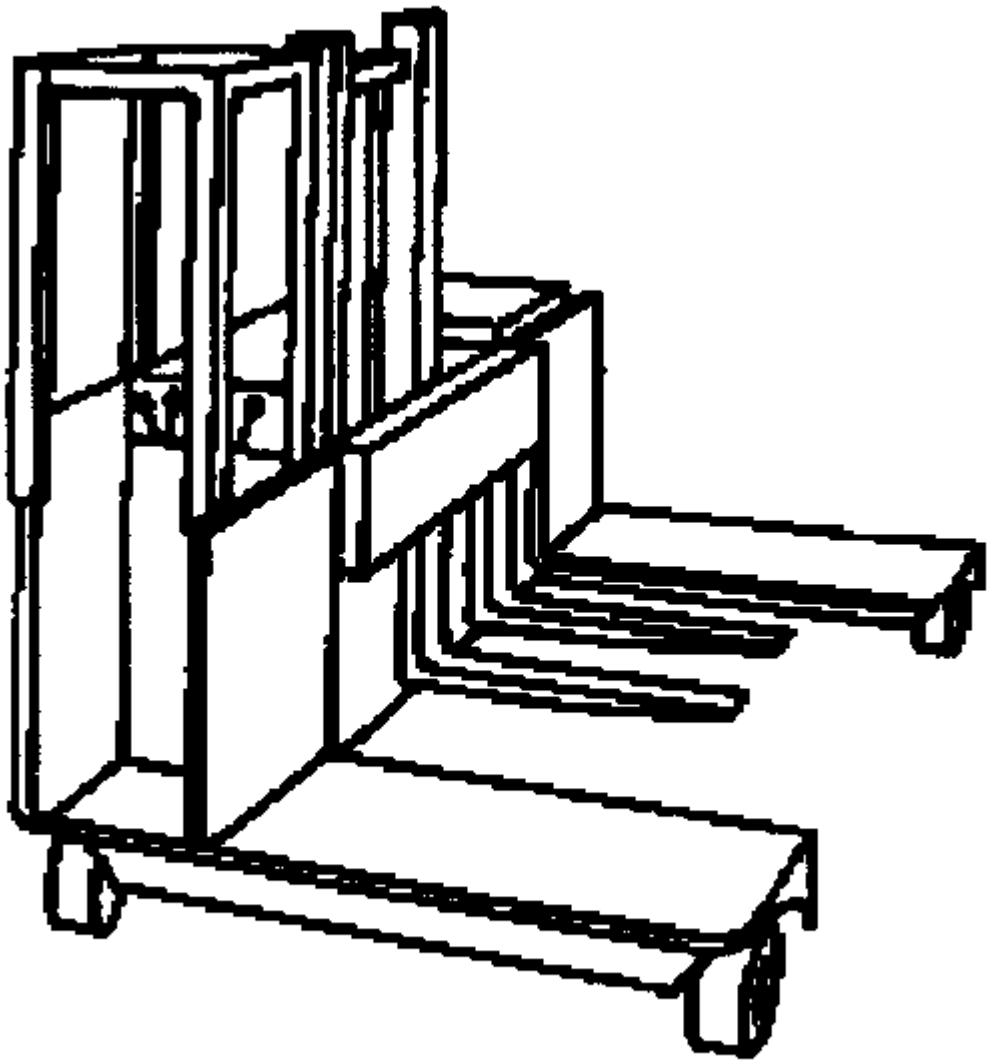
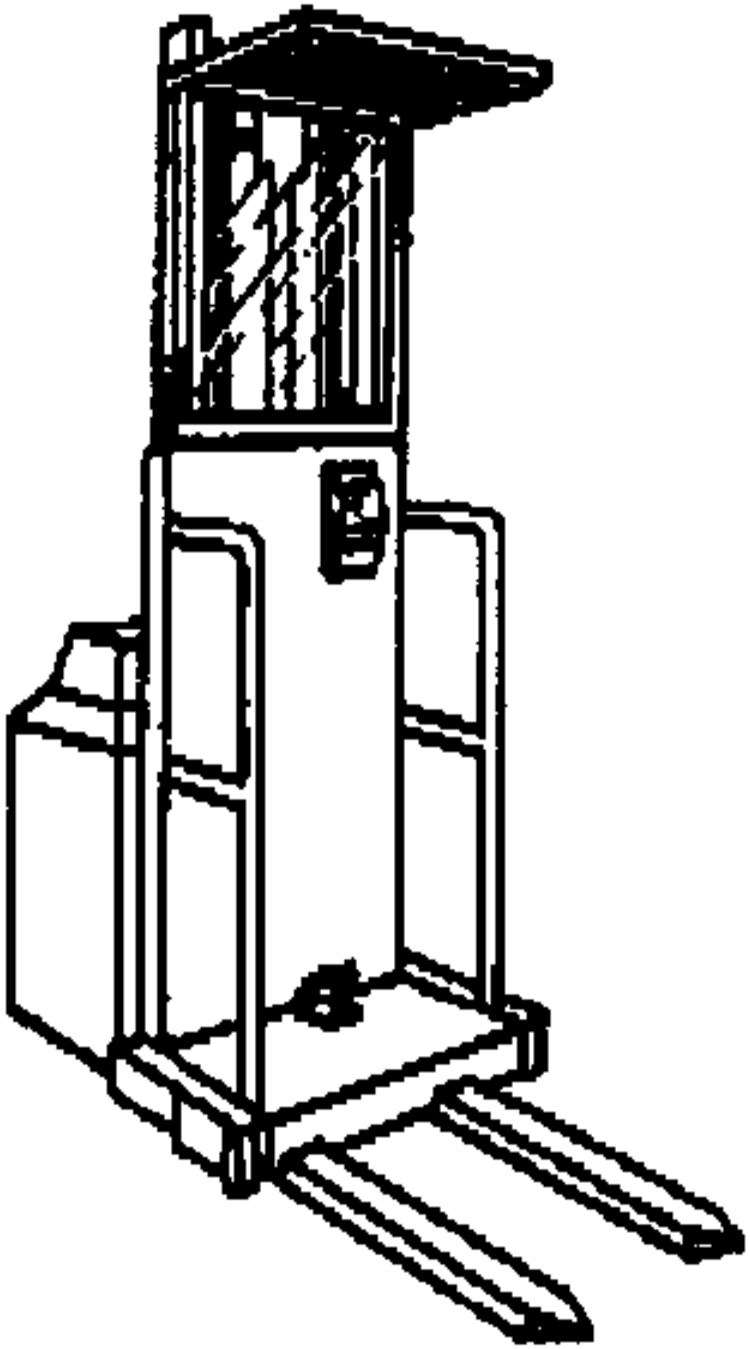


Figure 3.11. Order Picker Truck, High Lift.



NOTE: **Required guards to prevent truck movement, when the operator extends beyond the truck, have not been shown.**

Figure 3.12. Narrow-Aisle Truck (Also Known as Straddle Truck).

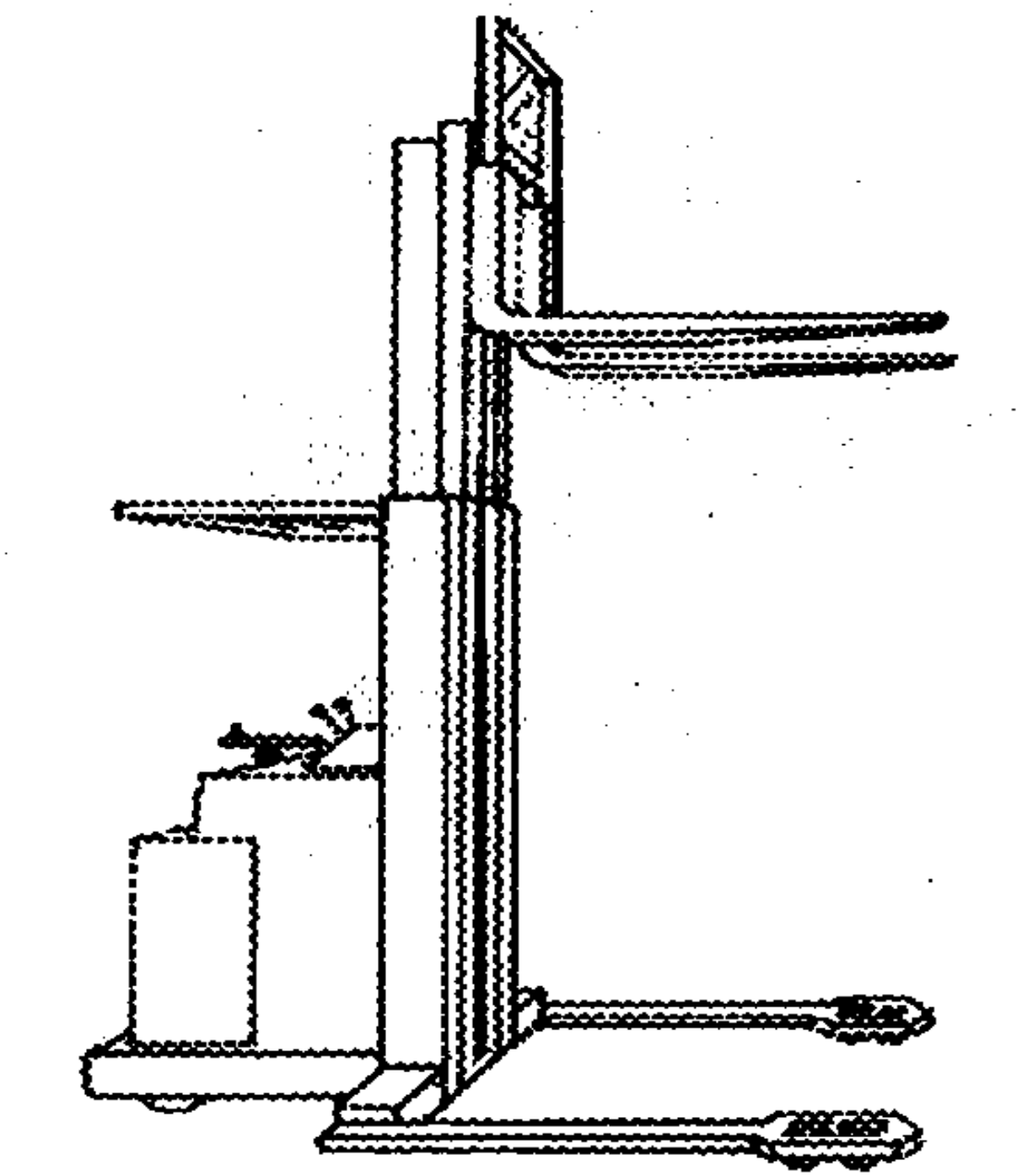


Figure 3.13. Truck, Straddle, Carry.

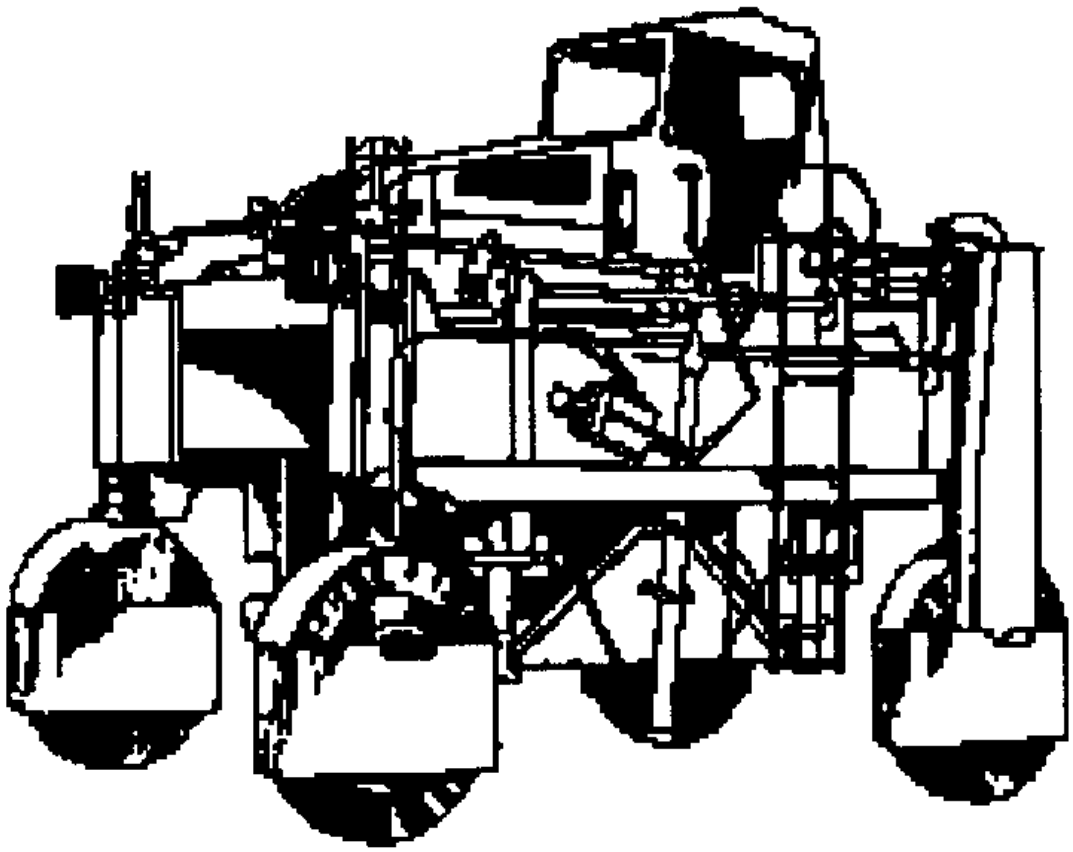


Figure 3.14. Truck, Warehouse, Double-Handle Type, 2-Wheel, Solid-Rubber Tires.

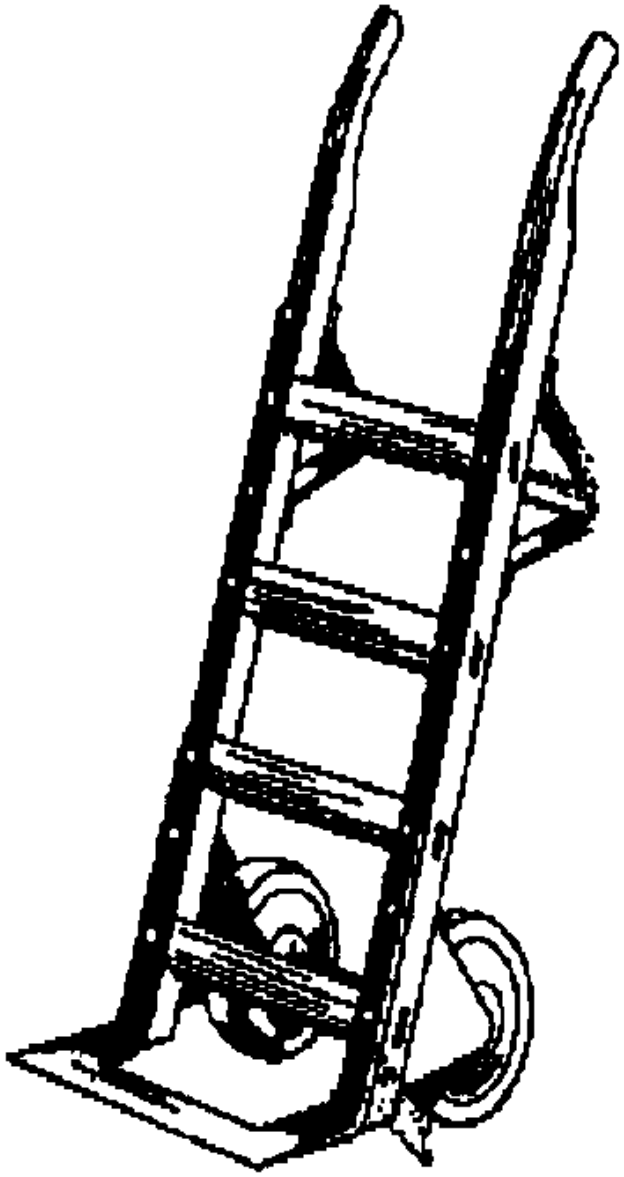


Figure 3.15. Truck, Hand, Platform, 4-Wheel.

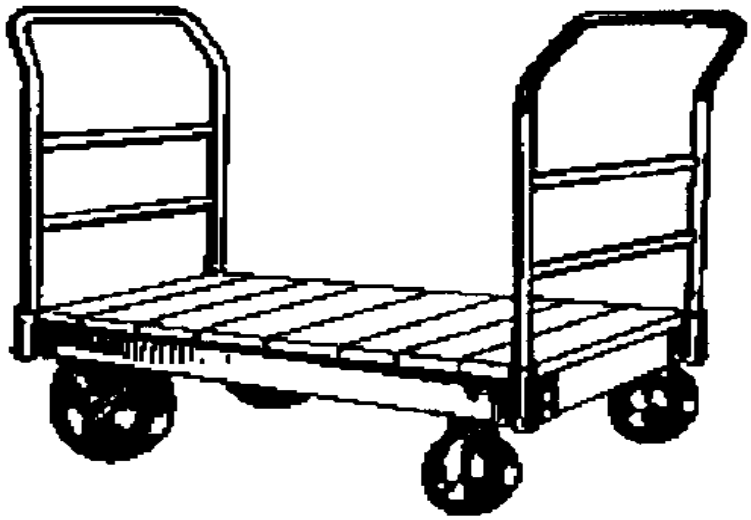


Figure 3.16. Crane Truck, Warehouse, Electric.

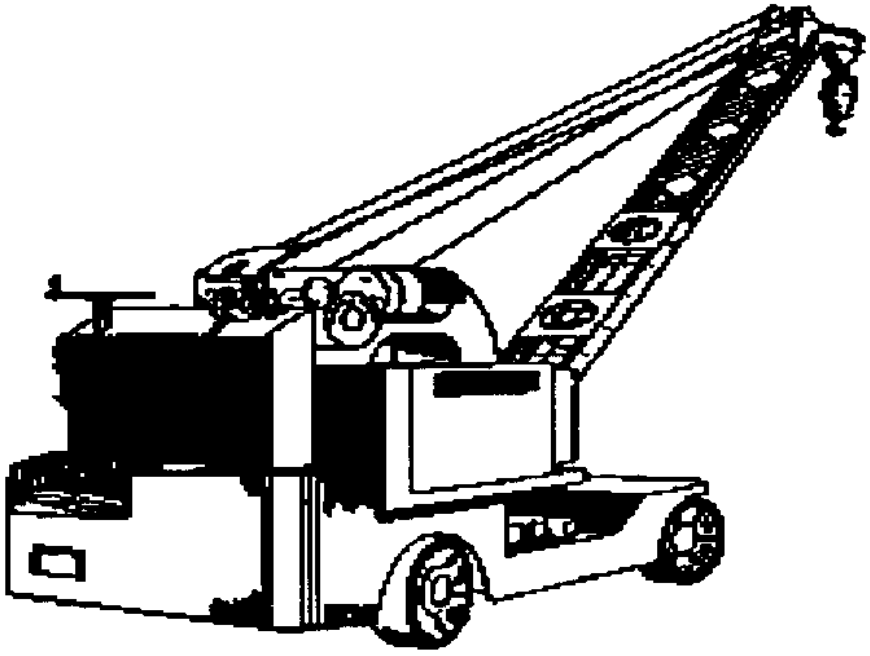
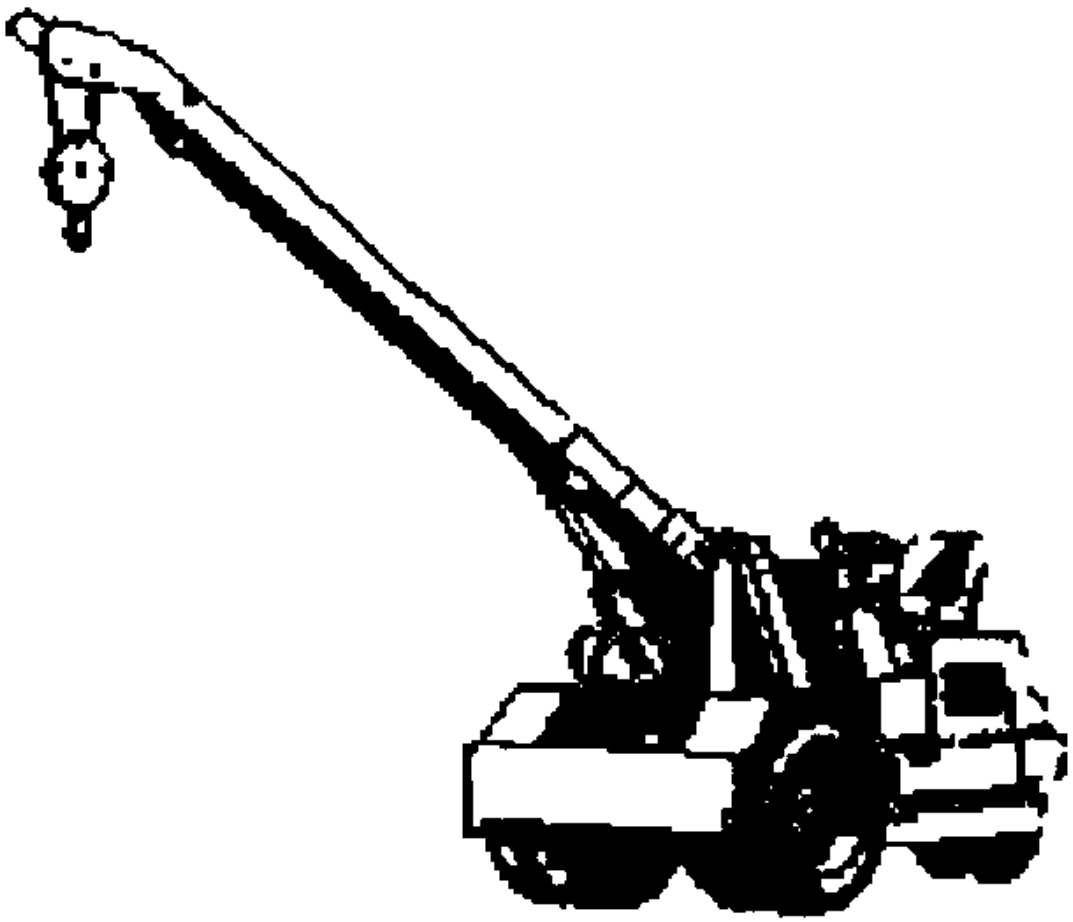


Figure 3.17. Crane Truck, Warehouse, Gasoline.



Chapter 4

CONVEYORS

4.1. Hazards and (or) Human Factors. Hand and finger injuries are frequently sustained when personnel place their hands between boxes or other objects on conveyors or attempt to remove or unjam objects. Injuries also occur from hand and (or) finger contact with conveyor rollers.

4.2. Requirements:

4.2.1. Acquisition:

4.2.1.1. Ensure all chains, sprockets, belts, couplings, and other moving parts to drive conveyors are enclosed or guarded.

4.2.1.2. Ensure a safety device is installed to prevent hands from being pinched between power and idler rollers.

4.2.1.3. Ensure all electric motors, controls, wiring, and their installation will conform to the specifications of NFPA 70, The National Electrical Code (NEC).

4.2.1.4. Ensure manually-operated hinged sections are designed with spring tension to minimize the effort required to move them.

4.2.1.5. Ensure mechanically-operated sections have positive catches or stops to hold them.

4.2.1.6. Ensure horizontally-hinged sections are designed so they cannot roll, vibrate, or shift out of the intended position.

4.2.1.7. Ensure all overhead conveyors have rails or roller guards to hold objects on the conveyor and sheet metal guards, wire mesh, or suitable material under the conveyor line to guard against material falling from the conveyors.

4.2.1.8. Ensure rails or guards are installed whenever there is danger of material falling from any conveyor.

4.2.1.9. Ensure all conveyors installed within 7 feet of the floor or surface have crossovers or passages.

4.2.1.10. If clear passageways cannot be provided under or around a conveyor, ensure crossover stiles are installed (if possible) so workers don't have to climb on the conveyor. Ensure stiles have stairs with nonslip treads, standard handrails, and 4-inch toeboards.

4.2.1.11. If a crossover cannot be installed to clear objects on the conveyor, ensure a hinge is installed so it can be swung out of the way when not in use.

4.2.1.12. If crossover stiles are not feasible, ensure metal plates with nonslip treads are installed in the conveyor just below and between the rollers. Ensure handrails that clear the load on the conveyor are provided.

4.2.1.13. Ensure all starting and stopping devices are clearly marked, clear of obstructions, and readily accessible.

4.2.1.14. Ensure all starting and stopping devices are recessed or guarded to prevent accidental contact by persons or moving objects.

4.2.1.15. If a conveyor has two or more stop switches, ensure such switches are arranged so the conveyor cannot be restarted until the actuating stop switch (the switch that originally broke the circuit) has been reset to running or "on" position.

4.2.1.16. Ensure electrical or mechanical interlocking devices, which will automatically stop a conveyor to prevent jam-ups, are provided.

4.2.1.17. Ensure the open end of every roller conveyor is equipped with a stop that projects automatically above the rollers when a hinged section is opened and retracts automatically when closed.

4.2.1.18. Ensure retarders, brakes, or similar devices are used to prevent loads from "running away" at or near the end of an inclined reciprocating conveyor.

4.2.1.19. Ensure hinged sections of a power conveyor are interlocked so they cannot be raised while the conveyor is in operation, or so the conveyor will stop automatically when a section is opened.

4.2.1.20. Ensure powered conveyors have lock-out switches so power can be locked out during maintenance.

4.2.2. Inspections. The supervisor will ensure the entire conveyor system is inspected daily. Defective parts that would affect the safe operation of the system will be replaced prior to continued operation. Operators will ensure crossover walkway surfaces are in good condition.

4.2.3. Maintenance. No work will be done on a power conveyor until the power switch or disconnect has been locked in the off position and (or) tagged out.

4.2.4. Training. Personnel will be thoroughly trained on procedures for:

4.2.4.1. Starting and stopping conveyors;

4.2.4.2. Loading and unloading conveyors to prevent overloading and jamming;

4.2.4.3. Clearing jams;

4.2.4.4. Making adjustments; and

4.2.4.5. Lockout and (or) tagout (see AFOSH Standard 127-45, Hazardous Energy Control and Mishap Prevention Signs and Tags.)

4.2.5. Safe Operations.

4.2.5.1. Personnel will not ride on a conveyor or step on or cross over conveyors except at designated locations.

4.2.5.2. Personnel will not operate conveyors unless all guards are in place.

4.2.5.3. Operators will check the entire conveyor before starting the system, to ensure it is clear of personnel.

4.2.5.4. Workers will place small objects in tote boxes on conveyors.

4.2.5.5. Personnel will not place hands or fingers between moving objects, fixed parts of the conveyor rollers, or on the rollers.

4.2.5.6. Personnel will not take off guards at the end of the conveyor and rollers or from belts feeding the conveyor.

4.2.5.7. Workers will use caution in resolving jam-up of boxes or other objects on the conveyor to prevent hand or finger injuries.

4.2.5.8. To prevent being struck by falling objects, workers will remain outside of the path of overhead conveyors.

4.2.5.9. Operators will report defective or worn shafts, rollers, or bearings that may break and permit rollers to fall from the frame.

4.2.5.10. Workers will not wear loose clothing, loose sleeves, or jewelry that may catch in the conveyor.

4.2.5.11. Workers will keep the area around them free of obstructions to permit a clear view of the conveyor and ready access to the devices.

Chapter 5

HOISTS

5.1. Hazards and (or) Human Factors. The most common hazards associated with hoists are overloading, dropping or slipping of the load caused by improper hitching or slinging, obstruction to the free passage of the load, failure to stabilize the load during the movement, failure to detect or correct equipment deficiencies or malfunctions, ignoring inspection or maintenance requirements, unfamiliarity with controls, and misuse of the equipment. Human factors such as inattention and failure to keep the load clear of people and objects are also factors which result in mishaps.

5.2. Requirements:

5.2.1. Acquisition. Overhead hoists will meet the design specifications, characteristics, and rules of ANSI and (or) American Society of Mechanical Engineers (ASME) Standards B30.7, Base Mounted Drum Hoists; B30.10, Hooks; and B30.16, Overhead Hoists (Underhung). When applicable, a system safety program will be established. The guidelines of Crane Manufacturer's Association of America, Inc. (CMAA) Specification Numbers 61 and 74 will be followed. Nuclear certified hoists must meet requirements in AFMAN 91-118, Safety Design and Evaluation Criteria for Nuclear Weapon Systems.

5.2.2. General:

5.2.2.1. Platforms. Hoist platforms will be made with suitable side and overhead protection to prevent operator injury from a falling load.

5.2.2.2. Signals. Standard operating signals, understood by operators and signalmen, will be used in hoist operations. (See **Figure 7.1.** for examples of approved signals.)

5.2.2.3. Engines and Motors. Hoist engines and motors will be guarded to protect personnel.

5.2.2.4. Brakes. Self locking brakes, capable of holding at least 125 percent of the rated load, will be installed on all hoists. A locking device, as applicable, will be provided to hold suspended loads.

5.2.2.5. Electric Hoists. The conductors and switches of electric hoists will be guarded against accidental contact.

5.2.2.6. Loads. All loads will be balanced on hoist carriages and secured to prevent slipping or shifting.

5.2.2.7. Monorail Hoists. This type of hoist will not be used to move an object by pulling sideways, unless properly designed for that purpose. Monorail hoists operated on swivels will be equipped with one or more safety catches that will support the load if a suspension pin fails. Each trolley frame will be safeguarded against spreading. The track supports and track of all monorails will be installed according to good engineering practices. They will be capable of safely carrying the loads for which they are intended. Rail stops will be provided at the ends of the monorail track. Such rail stops will extend at least as high as the radius of the wheels. At switches, turntables, and transfer tables, automatic bumpers shall drop onto position to prevent the trolley from running off the open ends of the fixed and movable track if they are not properly lined up with each other. Conversely, the track shall be interlocked with the bumpers so the track cannot move until the rail

stops are in position. ***Note: The track and its support will be inspected at least monthly for signs of weakness, wear, and (or) misalignment. If the monorail is located in a workplace not continuously occupied, such as a missile launch facility, this inspection should be accomplished prior to use***

5.2.2.8. Slack Chain. In cases where the slack chain hanging from a hoist may be a hazard to the operation, a chain container will be provided.

5.2.2.9. Hooks. Latch type safety hooks will be installed on all hoists.

5.2.2.10. Load Rating. The rated load will be permanently marked on the hoist and load block and will be clearly legible from the operating position.

5.2.2.11. Warnings. Information concerning operating procedures shall be either posted by all hoists or using a label, affixed to the hoist, controls, or block (see ANSI Standard B30-16):

5.2.2.11.1. Lifting more than the rated load.

5.2.2.11.2. Operating the hoist when the hook is not centered under the hoist.

5.2.2.11.3. Operating the hoist with twisted, kinked, or damaged chain or rope.

5.2.2.11.4. Operating a damaged or malfunctioning hoist.

5.2.2.11.5. Operating a rope hoist with a rope that is not properly seated in its groove.

5.2.2.11.6. Lifting people or loads over people.

5.2.2.11.7. Removing or obscuring the warning label.

5.2.2.12. Pendants. The pendant station will be supported by a cable, chain, or rope that will protect the electrical conductors against strain. Metallic pendant stations will be grounded to the hoist. Pendant control stations shall be kept clean and function labels kept legible.

5.2.2.13. Support. The supporting structure of the hoist, including trolleys, monorail, crane, or beam will have a load rating at least equal to that of the hoist.

5.2.2.14. Location. The hoist will be installed to give the operator room to stay free of the load at all times.

5.2.2.15. Hoist Controls. Hoist controls for trolley and bridge movement shall use compass points (north, south, east, and west) as the preferred identification whenever possible.

5.2.2.16. Synchronous Controls. Hoists utilizing synchronous controls for multiple lifting movements shall be of fail-safe design to preclude inadvertent operation caused by malfunction of selector switches, power failure, or improper sequencing of controls.

5.2.2.17. Remote Operated Hoists. Remote operated hoists shall function so that if the central signal for any hoist motion becomes ineffective, hoist motion shall stop.

5.2.2.18. Tag Lines. Tag lines will be used on free swinging loads to help guide and prevent striking nearby objects.

5.2.2.19. Upper Limit Switches. Upper limit switches shall be installed and operable for all powered hoists.

5.2.3. Operations:

5.2.3.1. Qualification of Operators:

5.2.3.1.1. Manually operated hoists will be operated only by those personnel who are trained and qualified to use the equipment. Power operated hoists will be operated only by qualified persons designated by the appropriate supervisor. Operator qualifications will be determined by the successful completion of a practical operating examination administered by a qualified operator or an instructor. Maintenance and test personnel and inspectors may also operate hoists in the performance of their duties.

5.2.3.1.2. Operators of power operated hoists shall meet the following minimum qualifications:

5.2.3.1.2.1. Have vision of at least 20/30 Snellen in one eye, and 20/50 in the other, with or without glasses.

5.2.3.1.2.2. Be able to distinguish red, green, and yellow, regardless of position of colors.

5.2.3.1.2.3. Test for ordinary conversation in one ear, with or without a hearing aid to ensure that there is adequate hearing for a specific operation.

5.2.3.1.2.4. Have sufficient strength, endurance, agility, coordination and speed of reaction to meet the demands of equipment operation.

5.2.3.1.2.5. Evidence of physical defect, or emotional instability which could render the operator a hazard to himself or others, or which in the opinion of the examiner or supervisor could interfere with the operator's safe performance, may be sufficient cause for disqualification. In such cases specialized clinical or medical judgments and tests may be required. ***Note: A history of epilepsy or a disabling heart condition may be sufficient reason for disqualification.***

5.2.3.1.3. Operators of cab-operated overhead, portal, tower, pedestal, and gantry cranes will be examined annually according to paragraphs **5.2.3.1.2.1.** through **5.2.3.1.2.3.** Requirements in paragraphs **5.2.3.1.2.4.** and **5.2.3.1.2.5.** are used for initial screening only.

5.2.3.1.4. Potential operator trainees will have good depth perception, field of vision, reaction time, manual dexterity or coordination, and no tendencies to dizziness or similar undesirable characteristics. Physical defects such as loss of arm, hand, leg, foot, or gross loss of function thereof may be considered as cause for denial of acceptance into an entry level training program for operators.

5.2.3.1.5. Initial and, if required, recurring physicals may be documented in item 7 of the AF Form 55.

5.2.3.2. Operating Practices:

5.2.3.2.1. If an operator must divert their attention while operating a hoist he or she will stop the hoist.

5.2.3.2.2. When an AF Form 979, **Danger,** AF Form 981, **Out of Order,** or AF Form 982, **Do Not Start,** tag is attached to the starting controls, the hoist operator will not apply power to the unit or start operations until the condition has been corrected and the tag removed. (Also see paragraph **5.2.4.3.3.**)

5.2.3.2.3. Before starting the hoist, the operator will be certain all personnel are clear of the area.

5.2.3.2.4. The operator will be familiar with the equipment and its proper care. If adjustments or repairs are necessary or any damage is observed or suspected, the operator will promptly report the problem to their supervisor.

5.2.3.2.5. All controls will be tested by the operator before beginning a shift. If any controls do not operate properly, they will be adjusted or repaired before operations are started. Limit switches will be checked under no-load conditions; exercising care at slow speeds.

5.2.3.2.6. The operator will make sure their hands are clear of all moving parts before operating the hoist.

5.2.3.2.7. On chain hoists the operator will have safe access to the hand chain.

5.2.3.2.8. Manual hoists will never be operated by other than hand power.

5.2.3.3. Handling the Load:

5.2.3.3.1. The rated load will not be exceeded except for properly authorized tests. If at any time it is known or suspected that a nuclear certified hoist may have been overloaded (other than a required and approved test load), take action to ensure that all inspections, daily through annual, are completed prior to use with nuclear loads.

5.2.3.3.2. The hoisting rope or chain will not be wrapped around the load.

5.2.3.3.3. The load will be attached to the hook equipped with safety latch by means of slings or other devices designed specifically for the load being lifted.

5.2.3.3.4. The slings or other devices will be seated properly in the saddle of the hook before operations begin.

5.2.3.3.5. The load will not be moved or lifted more than a few inches until it is well balanced in a sling or lifting device and center of gravity is known.

5.2.3.3.6. Care will be taken in hoisting to be certain that:

5.2.3.3.6.1. Hoist ropes or chains are not twisted about each other.

5.2.3.3.6.2. The load does not contact any obstruction.

5.2.3.3.6.3. Ropes or chains are protected against sharp edges of the load.

5.2.3.3.7. Before starting the hoist, the operator will ensure that the rope or chain is properly seated on the drum sheaves or sprockets.

5.2.3.3.8. A hoist will not be operated until the load is centered.

5.2.3.3.9. Hoists will not be operated until the hoist unit is centered over the load.

5.2.3.3.10. A hoist will not be used for hoisting personnel unless it has been specifically designed for this purpose and only if it is the safest means of accomplishing the work.

5.2.3.3.11. The operator will not carry loads over personnel.

5.2.3.3.12. The operator will test the brakes each time a load is handled by raising the load just enough to clear the floor, or supports, and check for brake action. The lift should be continued only after the operator has ensured the braking system is operating properly.

5.2.3.3.13. No loaded rope hoist drum will be rotated in the lowering direction beyond the point where less than two wraps of rope remain on the drum. Distinctive rope markings may be used to warn the operator the rope wrap limits are being reached.

5.2.3.3.14. The operator will inch the hoist upward to engage a load and avoid unnecessary stops and starts.

5.2.3.3.15. The operator will not leave a suspended load unattended.

5.2.3.3.16. The upper limit device will not be used as a normal operating control except to inch the hook into place for storage between use.

5.2.3.3.17. If a load must remain suspended for a considerable time, a pawl or other equivalent means, rather than the brake alone, shall be used to hold the load. The ground area below the suspended load shall be barricaded to prohibit entry of personnel or equipment.

5.2.4. Maintenance and Testing:

5.2.4.1. Operational and Load Tests. All new hoists, or those which have had load sustaining parts altered, replaced, or repaired, will be tested before use by the owner agency as outlined below. A record of all tests will be maintained by the using agency and the agency responsible for hoist maintenance and inspections.

5.2.4.1.1. The operational test will consist of operating all functions of the hoist under a no-load condition to test all functions of the hoist including hoisting and lowering, operation of brakes and testing of limit, locking, and safety devices.

5.2.4.1.2. The proof load test will consist of hoisting 125 percent the rated load. On hoists incorporating overload devices which prevent the lifting of 125 percent of the rated load, the load will be at least 100 percent of the rated load, after which the function of the overload device will be tested.

NOTES:

1. Use 110 percent in lieu of 125 percent for winches; this applies also to paragraph **5.2.4.1.3.**

2. Nuclear certified hoists require annual proof load testing at 125 percent. Do not use overload devices that prevent this testing.

5.2.4.1.3. Hoists, that are identified by the functional manager as being required to lift critical loads as defined in **Attachment 1** will be tested as stated in paragraphs **5.2.4.1.1.** and **5.2.4.1.2.** and annually thereafter at 100 percent of the rated load. **NOTE:** For nuclear certified hoists, perform a proof load test at 125 percent of the rated load annually.

5.2.4.1.4. Test weights utilized for rated load tests shall be tagged or adequately marked indicating total weight in pounds and owner and (or) agency identification number. Reinforcing (rebar) steel shall not be used for test weight lift points.

5.2.4.2. Preventive Maintenance. The using organization concerned will establish a preventive maintenance program based on the manufacturer's recommendations. These records should be maintained for the life of the equipment at the location determined by the unit.

5.2.4.3. Maintenance Procedures. Before adjustments and repairs are started on a hoist, the following precautions will be taken:

5.2.4.3.1. If electrically powered, the main switch on the line feeding the hoist will be locked in the open (off) position.

5.2.4.3.2. If air powered, the valve in the air line feeding the hoist will be closed with appropriate warning sign and (or) tag attached to the closed valve.

5.2.4.3.3. An AF Form 979, 981, or 982 tag will be placed on the hoist and the energy control locked out when adjustments, modifications, or repairs are scheduled. The hoist operator will not apply power to the equipment or start operations until the conditions have been corrected and the tag removed. (Refer to AFOSH Standard 127-45.)

5.2.4.3.4. Drum pawls will be engaged, or other means provided to prevent load ropes from inadvertently rotating the mechanism.

5.2.4.4. Adjustments and Repairs. Repair, replacements, or adjustments will be made to ensure correct performance of all hoist components. The following are examples:

5.2.4.4.1. Replace all worn braking components such as friction discs, ratchets, pawls, and pawl springs.

5.2.4.4.2. Replace worn, corroded, or otherwise damaged load chain and rope.

5.2.4.4.3. Replace hooks showing defects. Repair or replace damaged hook safety latches.

5.2.4.4.4. Replace all other load supporting components which are cracked, bent, or excessively worn.

5.2.4.4.5. Replace missing or illegible warning labels.

5.2.4.4.6. Replace pitted or burned electrical contacts in sets only. Lubricate controller parts as recommended by the manufacturer.

5.2.4.4.7. Keep pendant control stations clean and function labels legible.

5.2.4.4.8. Adjust all functional operating mechanisms, brakes and pawls, limit switches, and other limiting devices to ensure correct functioning of components.

5.2.4.5. Lubrication. All moving parts of the hoist, for which lubrication is specified, will be regularly lubricated. Particular care should be taken to follow manufacturer's recommendations as to points and frequency of lubrication, quantity, and type of lubricant to be used. Machinery will be stationary, with the energy source locked out, while lubricants are being applied. (See paragraph **5.2.4.3.3.**)

5.2.4.6. Rope Replacement and Maintenance. Refer to **Chapter 9**.

5.2.5. Inspections. The following items will be inspected for damage and (or) wear at intervals specified, including observations during operation. Deficiencies will be carefully examined and a determination made by the operator and the shop and (or) facility supervisor as to whether they constitute a safety hazard.

5.2.5.1. Daily or Prior to Use, Inspect:

5.2.5.1.1. All controls and operation mechanisms for proper operation. On pendant controls, inspect the electrical and support cable for condition and ensure all labels are present and legible.

5.2.5.1.2. All safety devices, including the upper limit switches, for proper operation. Block or hoist shall be "inched" into the limit switch to prevent possible damage.

5.2.5.1.3. Air systems for deterioration or leakage.

5.2.5.1.4. Load chain for wear, twists, breaks, cracks, or other damage to links. Check chain also for deposits of foreign material which may be carried into the hoist mechanism. At least monthly, the person performing the inspection will document the date, the identifier of the chain, and sign the record of inspection. The using organization will retain the record for a minimum of 1 year. (Also see paragraphs **9.2.1.3.** and **9.2.1.4.**)

5.2.5.1.5. Hooks for deformation, chemical damage, cracks, or defective safety latches. At least monthly, the person performing the inspection will document the date, the serial number or other identifier of the hook, and sign the record of inspection. The using organization will retain the record for a minimum of 1 year. Replace hooks having more than 15 percent in excess of normal throat opening or more than 10 degrees twist from plane of the unbent hook. Inspect (if possible) other load bearing components of the hoist for damage. (See paragraph **9.4.** for more information on nuclear certified hoists and paragraph **9.6.** for hoists approved for personnel lifts.)

5.2.5.1.6. Load carrying ropes for wear, twist distortion, broken wires or improper dead-ending to the hoisting drum and other attachments.

5.2.5.2. Periodic. A visual inspection performed at intervals between 1 and 12 months by a designated person who also maintains a record of the inspection. The recommended intervals of the periodic inspections should be based on the type of use experienced by the equipment as follows: Normal service - yearly; heavy service semiannually; severe service - quarterly. If accomplished properly, this inspection may require the removal of covers and (or) parts to gain access. The level of disassembly required during this inspection will be determined by the manufacturer representative or the inspector. Complete disassembly of the hoist or major components, not designed to be removed or opened for the sole purpose of the inspection, is not normally required. However, if the inspecting authority finds evidence of damage or wear that constitutes a potential hazard, further inspection to determine cause or to repair the system may be required and total disassembly or removal of major components may be necessary. The periodic inspection includes items in paragraph **5.2.5.1.**, plus the following. **NOTE:** For nuclear certified hoists, the periodic inspection is required to be performed semi-annually by the installation civil engineer or equivalent.

5.2.5.2.1. Cracked, unevenly worn, or damaged drums or sheaves. Sheave grooves will be smooth and free from surface irregularities which could cause rope damage.

5.2.5.2.2. Excessive wear on motor or load brake.

5.2.5.2.3. Excessive wear of chain, rope, load sprockets, drums, sheaves, and chain stretch.

5.2.5.2.4. Hook retaining nuts on collar and pins, welds, or riveting used to secure the retaining member.

5.2.5.2.5. Worn, glazed, or oil contaminated friction disc or worn pawls, cams, or ratchets on brake mechanisms, corroded, stretched, or broken pawl springs.

5.2.5.2.6. Worn, cracked, or distorted parts such as hook blocks, suspension housing, outrigger, hand chain wheels, chain attachments, clevises, yokes, suspension bolts, shafts, gears, bearings, pins, rollers, locking, and clamping devices.

5.2.5.2.7. Loose bolts, nuts, or rivets.

5.2.5.2.8. Continued ability to support the imposed loads of supporting structure and trolley, if used.

5.2.5.2.9. Signs of pitting or any deterioration of controller contactors, limit switches, and push button stations on electrical apparatus.

5.2.5.2.10. Additional annual requirements for nuclear certified hoists:

5.2.5.2.10.1. Perform dye penetrant, magnetic particle, or other suitable Non-Destructive Inspection (NDI) on the hook (refer to paragraph **9.4.** and **Figure 9.7.**)

5.2.5.2.10.2. Installation civil engineer or equivalent will perform an annual load test at 125 percent of the manufacturer's rated load.

5.2.5.3. Hoists Not in Regular Use. A hoist which has been idle for 6 months or more will be given a complete inspection conforming with the requirements of paragraph **5.2.5.2.**

5.2.5.4. Inspection Records. A written, dated, and signed record of all hoist, chain, and rope inspections will be maintained by the shop and (or) facility supervisor and be readily available.

5.2.5.5. Rope Inspection. Refer to **Chapter 9**.

5.2.5.6. Welded Link Chain Inspection. Refer to **Chapter 9** and paragraph **5.2.5.1.4.**

Chapter 6

SLINGS

6.1. Hazards and (or) Human Factors:

6.1.1. Slings have the potential to cause injury, death, and property damage. Mishaps are mostly caused by loads being dropped, or slipping, because either the sling or its attachments break or otherwise fail. The usual causes are inadequate design, improper selection, poor inspection, failure to make sure that loads are properly attached and secured, or improper storage and care.

6.1.2. Human error contributes to most sling mishaps. The most common is that supervisors allow untrained and unqualified people to use and maintain slings. Other causes are:

6.1.2.1. Use of damaged or defective slings.

6.1.2.2. Unauthorized modifications to slings.

6.1.2.3. Kinks in supporting ropes and cables.

6.1.2.4. Overloaded slings.

6.1.2.5. Improperly balanced loads which allows them to slip.

6.1.2.6. Loads not securely attached to the slings.

6.1.2.7. Sling failure caused by not using pads to protect the sling from being damaged by sharp edges or corners.

6.1.2.8. Loads hitting obstructions.

6.1.2.9. Personnel standing or walking under suspended loads.

6.1.2.10. Personnel placing their hands between the sling and load before the sling is tightened around the load.

6.1.2.11. Sling failure caused by damage when slings are pulled from under a load.

6.1.2.12. Improperly rigged loads.

6.1.2.13. Use of unauthorized equipment such as cargo straps as slings.

6.2. General Requirements:

6.2.1. Acquisition. Procurement of slings for use in the Air Force will comply with the design and manufacturing requirements for all slings and be according to 29 CFR 1910.184, Slings, and ANSI B30.9, Slings. Specifications for procurement of slings will contain enough information to ensure that manufacturers comply with all design, construction, and testing criteria in the references above.

6.2.2. Inspection and Testing.

6.2.2.1. Slings will be marked or identified on the sling or on durable and legible tags or labels as follows:

6.2.2.1.1. Alloy steel chain slings are required to be marked with the size, manufacturer's grade, rated load and angle upon which the rating is based, its reach, number of legs, and manufacturer's name.

6.2.2.1.2. Wire rope slings should be marked to identify the rated load and manufacturer.

6.2.2.1.3. Metal mesh slings will be marked with manufacturer's name or trademark and the rated load in vertical basket hitch and choker hitch.

6.2.2.1.4. Synthetic webbing slings will be permanently marked to identify the name of the manufacturer, the manufacturer's code or stock number, the rated load for types of hitches used, and the type of synthetic material.

6.2.2.2. Sling attachments or assemblies such as hooks, rings, oblong or pear-shaped links, or welded or mechanical coupling link will have a rated capacity at least equal to that of the sling rated capacity.

6.2.2.3. The using organization will inspect each sling assembly as follows:

6.2.2.3.1. A visual inspection will be made before the sling is used. If evidence of damage or abuse is detected, the sling will be removed from service, repaired, and tested before further use.

6.2.2.3.2. Slings and attachments will be inspected monthly. If a sling assembly is used less than once a month, it will be inspected before each use. The monthly inspection will be documented and the most recent month kept on file by the using organization.

6.2.2.3.3. All slings will be inspected once a year using the following procedures: ***Note: For nuclear certified slings and wire rope assemblies, use the appropriate 11N series TOs for inspection and maintenance criteria.***

6.2.2.3.3.1. Remove all dirt, grease, or oil from all components of the sling.

6.2.2.3.3.2. Visually inspect all parts for excessive wear, deformations, fraying, stretching, and any other defects that may reduce the sling's rated capacity.

6.2.2.3.3.3. Remove the sling from service if any component shows defects or deterioration.

6.2.2.3.3.4. Update the sling identification tag to document the annual inspection.

6.2.3. Proof Testing.

6.2.3.1. Proof testing to identify sling-rated capacity will be performed with only approved and calibrated weight testing equipment. A record of the most recent proof test will be retained on file.

6.2.3.2. Slings will be initially proof tested at 200 percent of rated capacity. Synthetic and natural fiber rope slings will be proof tested at two times their assigned rated loads before being put into service. ***Note: Wire rope slings of the hand-tucked type and certain special spreader-bars and lifting beams are limited to test loads of 125 percent.***

6.2.3.3. Proof load for single leg and endless slings shall be two times the vertical rated capacity.

6.2.3.4. Proof load for multileg bridle slings shall be applied to the individual legs and shall be two times the vertical rated capacity of a single leg sling of the same size, grade, and construction of rope.

6.2.3.5. Proof testing at 200 percent of rated capacity of slings, spreader-bars, lifting beams, and other specialized lifting attachments used to lift critical loads, shall be performed annually. (See **Attachment 1** for critical load definition.) (Also, see NOTE in paragraph **6.2.3.2.**)

6.3. Specific Requirements:

6.3.1. Alloy Steel Chain Slings:

6.3.1.1. Hooks, rings, oblong or pear-shaped links, welded or mechanical coupling links, or other attachments will have a rated capacity at least equal to that of the alloy steel chain with which they are used. The sling will not be loaded in excess of the rated capacity of the weakest component.

6.3.1.2. Unauthorized makeshift links or fasteners, such as those formed from bolts or rods, will not be used.

6.3.1.3. Each new, repaired, or reconditioned alloy steel chain sling, including all welded components in the sling assembly, will be proof tested to 200 percent of rated capacity before being used.

6.3.1.4. Alloy steel chain slings will not be used with loads more than the rated capacities prescribed in **Table 6.1.**. Slings not included in this table will be used only according to the manufacturer's recommendations.

6.3.1.5. Alloy steel chain slings will be permanently removed from service if they are exposed to heat above 1,000 degrees Fahrenheit (F). When exposed to service temperature in excess of 600 degrees F, maximum working load limits permitted in **Table 6.1.** will be reduced according to the chain or sling manufacturer's recommendations.

6.3.1.6. Worn or damaged alloy steel chain slings and attachments will not be used until they are repaired (or reconditioned) and proof tested.

6.3.1.7. Mechanical coupling links or low carbon steel repair links will not be used to repair broken lengths of chain.

6.3.1.8. If the chain size at any point of any link is less than that stated in **Table 6.2.** the sling will be removed from service.

6.3.1.9. Alloy steel chain sling with cracked or deformed master links, coupling links, or other components will be removed from service.

6.3.1.10. Slings will be removed from service if hooks are cracked, have been opened more than 15 percent of the normal throat opening measured at the narrowest point, or twisted more than 10 degrees from the plane of the unbent hook.

6.3.2. Wire Rope Slings:

6.3.2.1. Wire rope slings will not be used with loads in excess of the rated capacities shown in **Table 6.3.** through **Table 6.14.**. Slings not included in these tables will be used only according to the manufacturer's recommendations. (See paragraph **9.1.1.4.**. for proper wire rope attaching.)

6.3.2.2. Minimum sling lengths are determined as follows:

6.3.2.2.1. Cable laid and 6 by 19 and 6 by 37 slings will have a minimum clear length of wire rope between splices, sleeves, or end fittings ten times the component rope diameter.

6.3.2.2.2. Braided slings will have a minimum clear length of wire rope between splices, sleeves, or end fittings forty times the component rope diameter.

6.3.2.2.3. Cable laid grommets, strand laid grommets, and endless slings will have a minimum circumferential length of 96 times their body diameter.

6.3.2.3. Fiber core wire rope slings of all grades will be permanently removed from service if they are exposed to temperatures in excess of 200 degrees F. When nonfiber core wire rope slings of any grade are used at temperatures above 400 degrees F or below minus 60 degrees F, recommendations of the sling manufacturer regarding use at that temperature will be followed.

6.3.2.4. End attachments, except covers to thimbles, will be welded before the sling is assembled.

6.3.2.5. Welded end attachments will be proof tested at twice their rated capacity prior to initial use. The owning agency shall maintain a record or certificate of proof test and make it available for inspection.

6.3.2.6. Wire rope slings will be removed from service if any of the following conditions are present:

6.3.2.6.1. Ten randomly distributed broken wires in one rope lay or five broken wires in one strand in one rope lay.

6.3.2.6.2. Wear or scraping of one-third the original diameter of outside individual wires.

6.3.2.6.3. Kinking, crushing, bird caging, or any other damage resulting in distortion of the wire rope structure.

6.3.2.6.4. Evidence of heat damage.

6.3.2.6.5. End attachments that are cracked, deformed, or worn.

6.3.2.6.6. Hooks that have been opened more than 15 percent of the normal throat opening measured at the narrowest point or twisted more than 10 degrees from the plane of the unbent hook.

6.3.2.6.7. Corrosion of the rope or end attachments.

6.3.2.7. Only new rope shall be used to fabricate slings. Use of repaired or reconditioned rope is prohibited.

6.3.2.8. Slings used in choker hitch shall be long enough so the choke point is on the rope and never on a splice.

6.3.3. Metal Mesh Slings:

6.3.3.1. Handles will have a rated capacity at least equal to the metal fabric and exhibit no deformation after proof testing.

6.3.3.2. The fabric and handles will be joined so that:

6.3.3.2.1. The rated capacity of the sling is not reduced.

6.3.3.2.2. The load is evenly distributed across the width of the fabric.

6.3.3.2.3. Sharp edges will not damage the fabric.

6.3.3.3. Coatings which damage the sling and diminish the rated capacity will not be applied.

6.3.3.4. All new and repaired metal mesh slings, including handles, will be proof tested at a minimum of one and one-half times their rated capacity before they are used. Elastomer impregnated slings will be proof tested before they are coated.

6.3.3.5. Metal mesh slings will not be used to lift loads in excess of their rated capacities prescribed in **Table 6.15.**. Slings not included in this table will be used only according to the manufacturer's recommendations.

6.3.3.6. Each metal mesh sling shall have a durable marking permanently attached that states the rated capacity for vertical basket hitch and choker hitch loadings and marked with the manufacturer's name.

6.3.3.7. Metal mesh slings which are not impregnated with elastomers may be used in a temperature range from minus 20 degrees F to plus 550 degrees F without decreasing the working load limit. Metal mesh slings impregnated with polyvinyl chloride or neoprene may be used only in a temperature range from zero degrees to plus 200 degrees F. For operations outside these temperature ranges or for metal mesh slings impregnated with other materials, the sling manufacturer's recommendations will be followed.

6.3.3.8. Metal mesh slings will be removed from service if any of the following conditions are present:

6.3.3.8.1. Broken weld or broken brazed joint along the sling edge.

6.3.3.8.2. Reduction in wire diameter of 25 percent due to abrasion or 15 percent due to corrosion.

6.3.3.8.3. Lack of flexibility due to distortion of the fabric.

6.3.3.8.4. Distortion of the female handle so the depth of the slot is increased more than 10 percent.

6.3.3.8.5. Distortion of either handle so the width of the eye is decreased more than 10 percent.

6.3.3.8.6. Reduction of 15 percent of the original cross-sectional area of metal at any point around the handle eye.

6.3.3.8.7. Distortion of either handle out of its plane.

6.3.3.8.8. Cracked end fitting.

6.3.3.8.9. A broken wire in any part of the mesh.

6.3.4. Natural and Synthetic Fiber Rope Slings:

6.3.4.1. Fiber rope slings made from conventional three-strand construction fiber rope will not be used with loads in excess of the rated capacities prescribed in **Table 6.16.** through **Table 6.19.**

6.3.4.2. Cargo straps will not be used as a sling or part of a sling configuration.

6.3.4.3. Slings not included in these tables will be used only according to the manufacturer's recommendations.

6.3.4.4. Fiber rope slings will have a diameter of curvature meeting at least the minimums specified in **Figure 6.1.** and **Figure 6.2.**.

6.3.4.5. Natural and synthetic fiber rope slings, except for wet frozen slings, may be used in a temperature range from -20 degrees F (-7 degrees Celsius [C]) to 150 degrees F (66 degrees C) without decreasing the working load. For operations outside this temperature range and for wet

frozen slings, or where rope and slings have been stored in a chemically active environment, the sling manufacturer's recommendations shall be followed.

6.3.4.6. Spliced fiber rope slings will not be used unless they have been spliced according to the following minimum requirements and any additional recommendation of the manufacturer:

6.3.4.6.1. In manila rope, eye splices will consist of at least three full tucks. Short splices will consist of at least six full tucks, three on each side of the splice center line.

6.3.4.6.2. In synthetic fiber rope, eye splices will consist of at least four full tucks. Short splices will consist of at least eight full tucks, four on each side of the center line.

6.3.4.6.3. Strand end tails will not be trimmed flush with the surface of the rope immediately adjacent to the full tucks. This applies to all types of fiber rope and both eye and short splices. For fiber rope under 1 inch in diameter, the tail will project at least six rope diameters beyond the last full tuck. For fiber rope 1 inch in diameter and larger, the tail will project at least six rope diameters beyond the last full tuck. Where a projecting tail interferes with the use of the sling, the tail will be tapered and spliced into the body of the rope using at least two additional tucks (which will require a tail length of approximately six rope diameters beyond the last full tuck).

6.3.4.6.4. Fiber rope slings will have a minimum clear length of rope between eye splices equal to ten times the rope diameter.

6.3.4.6.5. For all eye splices, the eye will be sized to provide an included angle of not greater than 60 degrees at the splice when the eye is placed over the load or support.

6.3.4.6.6. Only clamps specifically designed for fiber ropes will be used for splicing.

6.3.4.6.7. Knots will not be used in lieu of splices.

6.3.4.7. Fiber rope slings will not be used if end attachments that contact the rope have sharp edges or projections.

6.3.4.8. Natural and synthetic fiber rope slings will be removed from service if any of the following conditions are present:

6.3.4.8.1. Abnormal wear.

6.3.4.8.2. Powdered fiber between strands.

6.3.4.8.3. Broken or cut fibers.

6.3.4.8.4. Variations in the size or roundness of strands.

6.3.4.8.5. Discoloration or rotting.

6.3.4.8.6. Distortion of hardware in the sling.

6.3.4.9. Only new rope will be used to make fiber rope slings. Use of repaired or reconditioned fiber rope in slings is prohibited.

6.3.5. Synthetic Web Slings:

6.3.5.1. In addition to the general identification requirements, each sling will be marked to show the type of synthetic web material.

6.3.5.2. Synthetic webbing will be of uniform thickness and width and selvage edges will not be split from the webbing's width.

6.3.5.3. Fittings will be:

6.3.5.3.1. Of a minimum breaking strength equal to that of the sling; and

6.3.5.3.2. Free of all sharp edges that could damage the webbing.

6.3.5.4. Stitching will be the only method used to attach end fittings to webbing and to form eyes. The thread will have an even pattern and contain a sufficient number of stitches to develop the full breaking strength of the sling.

6.3.5.5. Synthetic web slings illustrated in **Figure 6.3.** will not be used with loads in excess of the rated capacities specified in **Table 6.20.** through **Table 6.22.** Slings not included in these tables will be used only according to the manufacturer's recommendations.

6.3.5.6. When synthetic web slings are used, the following precautions will be taken:

6.3.5.6.1. Nylon web slings will not be used where acid or phenolic fumes, vapors, sprays, mists, or liquids are present.

6.3.5.6.2. Polyester and polypropylene web slings will not be used where caustic fumes, vapors, sprays, mists, or liquids of acids are present.

6.3.5.6.3. Web slings with aluminum fittings will not be used where caustic fumes, vapors, sprays, mists, or liquids are present.

6.3.5.7. Synthetic web slings of polyester and nylon shall not be used at temperatures in excess of 180 degrees F. Polypropylene web slings will not be used at temperatures in excess of 200 degrees F.

6.3.5.8. Each repaired sling will be proof tested to twice the rated capacity before it is returned to service.

6.3.5.9. Slings, including webbing and fittings, with temporary or makeshift repairs will not be used.

6.3.5.10. Synthetic web slings will be removed from service if any of the following conditions are present:

6.3.5.10.1. Damage from acid or caustic materials.

6.3.5.10.2. Melting or charring of any part of the sling surface.

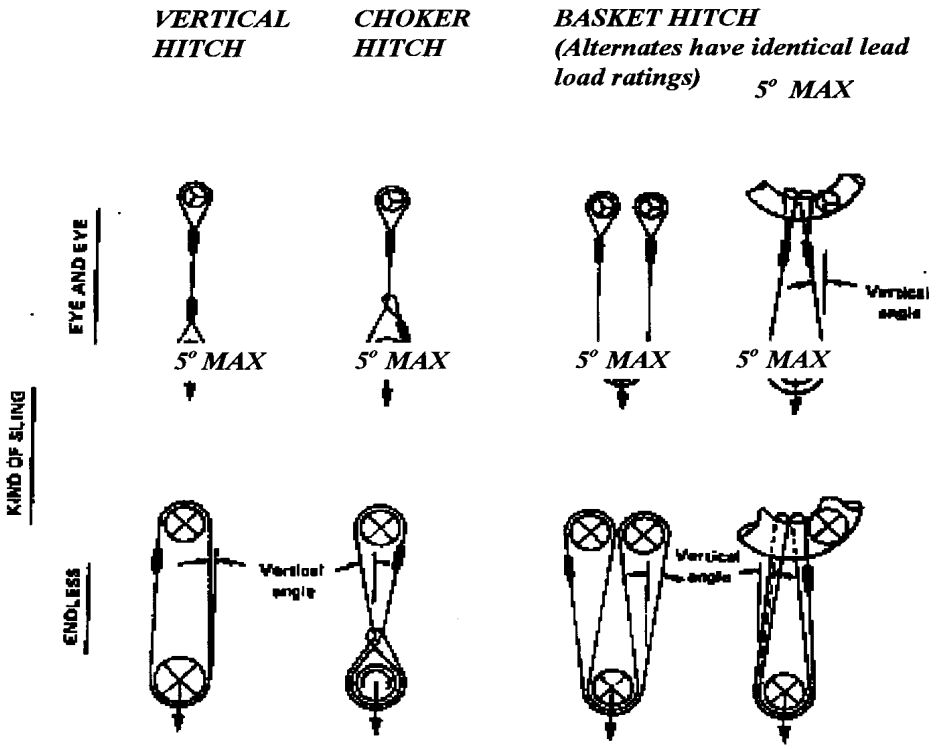
6.3.5.10.3. Snags, punctures, tears, or cuts.

6.3.5.10.4. Broken or worn stitches.

6.3.5.10.5. Distortion of fittings.

6.3.5.11. When not in use, slings will be kept in clean, dry storage areas that will protect the sling materials.

Figure 6.1. Basic Sling Configurations With Vertical Legs.



NOTES:
1. Angle 5 degrees or less from the vertical may be considered vertical angles.
2. For slings with legs more than 5 degrees off vertical, the actual angle as shown in Figure 6-2 must be considered.

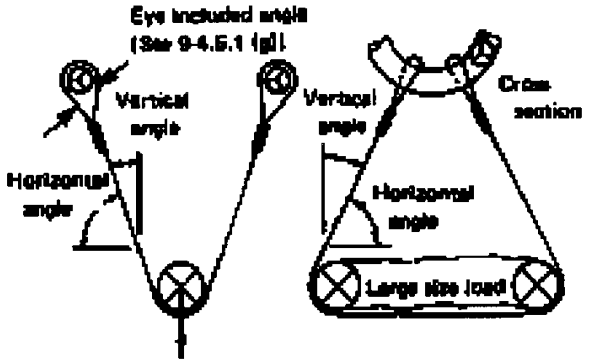
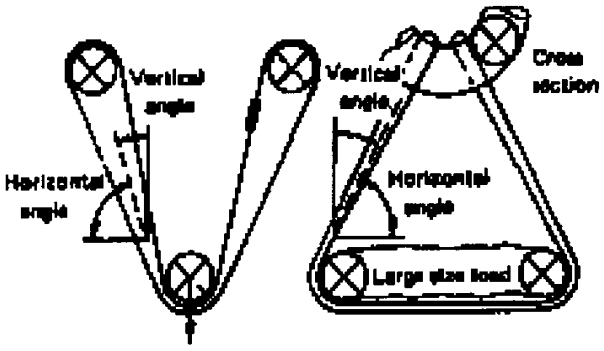
EXPLANATION OF SYMBOLS: MINIMUM DIAMETER OF CURVATURE

REPRESENTS A CONTACT SURFACE WHICH SHALL HAVE A DIAMETER OF CURVATURE AT LEAST DOUBLE THE DIAMETER OF THE ROPE FROM WHICH THE SLING IS MADE

REPRESENTS A CONTACT SURFACE WHICH SHALL HAVE A DIAMETER OF CURVATURE AT LEAST 8 TIMES THE DIAMETER OF THE ROPE.

REPRESENTS A LOAD IN A CHOKER HITCH AND ILLUSTRATES THE ROTARY FORCE ON THE LOAD AND (OR) THE SLIPPAGE OF THE ROPE IN CONTACT WITH THE LOAD. DIAMETER OF CURVATURE OF LOAD SURFACE SHALL BE AT LEAST DOUBLE THE DIAMETER OF THE ROPE.

Figure 6.2. Sling Configurations with Angled Legs.

KIND OF SLING	FORM OF HITCH: VERTICAL HITCH	FORM OF HITCH: CHOKER HITCH	FORM OF HITCH: BASKET HITCH (Alternates have identical lead load ratings
EYE AND EYE	NOT APPLICABLE	NOT APPLICABLE	
ENDLESS	NOT APPLICABLE	NOT APPLICABLE	

NOTES:

1. For vertical angles of 5 degrees or less, refer to Figure 6-1.

2. See Figure 6-1 for symbol explanation.

Figure 6.3. Basic Synthetic Web Sling Configurations.

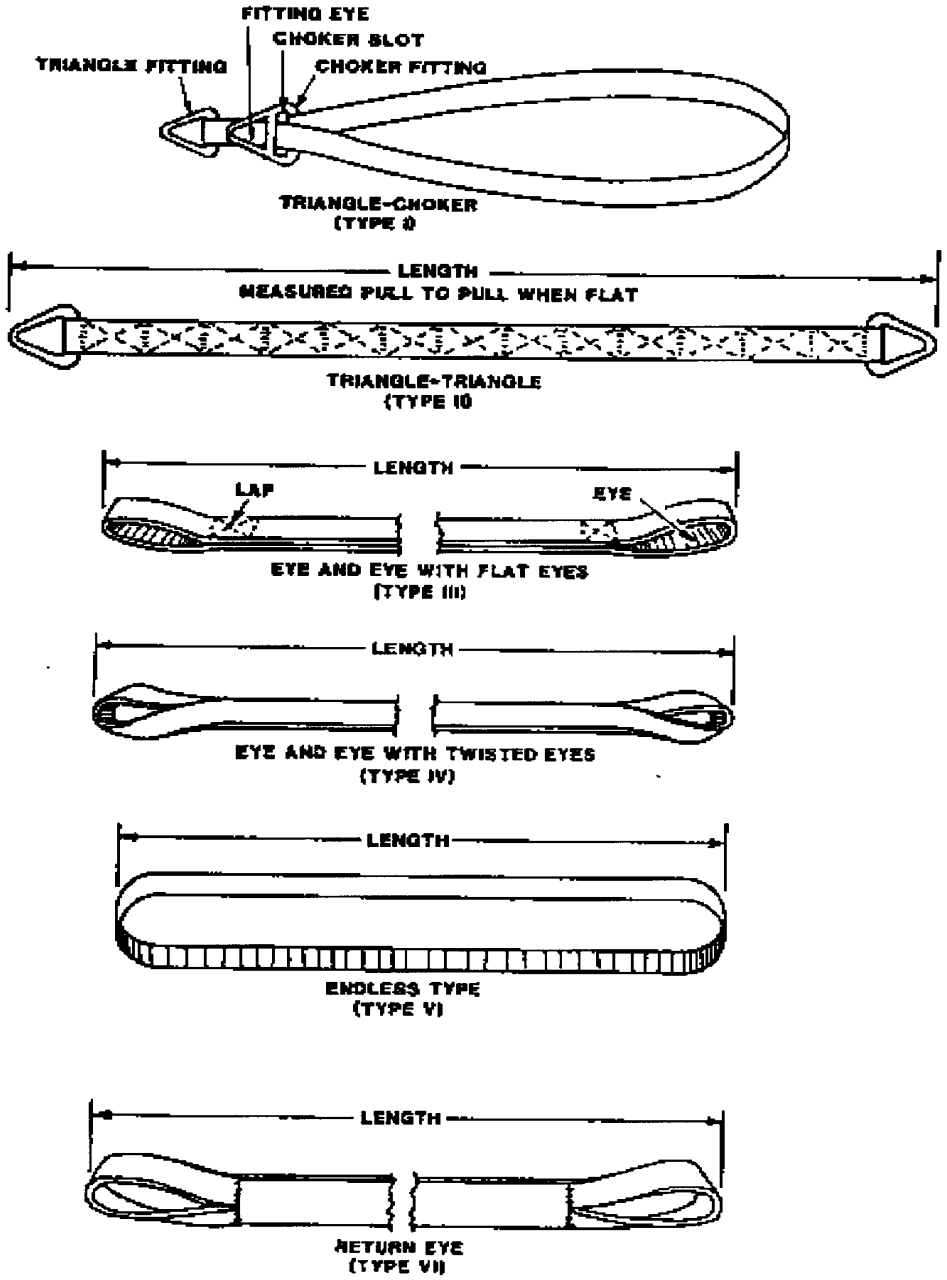


Table 6.1. Maximum Safe Working Load "A" Type Alloy Steel Chain Single Vertical Sling.

Chain Size, Inches	Single Branch Sling - 90 deg Loading	Double Sling			Triple and Quadruple Sling (3)		
		Vertical Angle (1)			Vertical Angle (1)		
		30 deg	45 deg	60 deg	30 deg	45 deg	60 deg
		Horizontal Angle (2)			Horizontal Angle (2)		
		(60 deg)	(45 deg)	(30 deg)	(60 deg)	(45 deg)	(40 deg)
1/4	3,250	5,650	4,550	3,250	8,400	6,800	4,900
3/8	6,600	11,400	9,300	6,600	17,000	14,000	9,900
1/2	11,250	19,500	15,900	11,250	29,000	24,000	17,000
5/8	16,500	28,500	23,300	16,500	43,000	35,000	25,500
3/4	23,000	39,800	32,500	23,000	59,500	48,500	39,500
7/8	28,750	49,800	40,600	28,750	74,500	61,000	43,000
1	38,750	67,100	5,800	38,750	101,000	82,000	58,000
1-1/8	44,500	77,000	63,000	44,500	115,500	94,500	66,500
1-1/4	57,500	99,500	61,000	57,500	149,000	121,500	86,000
1-3/8	67,000	116,000	94,000	67,000	174,000	141,000	100,500
1-1/2	80,000	138,000	112,500	80,000	207,000	169,000	119,500
1-3/4	100,000	172,000	140,000	100,000	258,000	210,000	150,000

NOTES:

(1) Rating of multileg slings adjusted for angle of loading measured as the included angle between the inclined leg and the vertical as shown in Figure 6-2.

(2) Rating of multileg slings adjusted for angle of loading between the inclined leg and the horizontal plane of the load, as shown in Figure 6-2.

(3) Quadruple sling rating is the same as triple sling because normal lifting practice may not distribute load uniformly to all four legs.

Table 6.2. Minimum Allowable Chain Size at Any Point of Link.

Chain Size, Inches	Minimum Allowable Chain Size Inches
1/4	13/64
3/8	19/64
1/2	25/64
5/8	31/64
3/4	19/32
7/8	45/64
1	13/16
1-1/8	29/32
1-1/4	1
1-3/8	1- 3/32
1-1/2	1- 3/16
1-3/4	1-13/32

Table 6.3. Rated Capacities for Single Leg Slings, 6x19 and 6x37 Classification Improved Plow Steel Grade Rope With Fiber Core (FC).

Rope		Rated Capacities, Tons (2,000 Lb)								
Dia		Vertical			Choker			Vertical Basket[1]		
(Inches)	Constr	HT	MS	S	HT	MS	S	HT	MS	S
1/4	6 x 19	0.49	0.51	0.55	0.37	0.38	0.41	0.99	1.0	1.1
5/16	6 x 19	0.76	0.79	0.85	0.57	0.59	0.64	1.5	1.6	1.7
3/8	6 x 19	1.1	1.1	1.2	0.80	0.85	0.91	2.1	2.2	2.4
7/16	6 x 19	1.4	1.5	1.6	1.1	1.1	1.2	2.9	3.0	3.3
1/2	6 x 19	1.8	2.0	2.1	1.4	1.5	12.6	3.7	3.9	4.3
9/16	6 x 19	2.3	2.5	2.7	1.7	1.9	2.0	4.6	5.0	5.4
5/8	6 x 19	2.8	3.1	3.3	2.1	2.3	2.5	5.6	6.2	6.7
3/4	6 x 19	3.9	4.4	4.8	2.9	3.3	3.6	7.8	8.8	9.5
7/8	6 x 19	5.1	5.9	6.4	3.9	4.5	4.8	10.0	12.0	13.0
1	6 x 19	6.7	7.7	8.4	5.0	5.8	6.3	13.0	15.0	17.0
1-1/8	6 x 19	8.4	9.5	10.0	6.3	7.1	7.9	17.0	19.0	21.0
1-1/4	6 x 37	9.8	11.0	12.0	7.4	8.3	9.2	20.0	22.0	25.0
1-3/8	6 x 37	12.0	13.0	15.0	8.9	10.0	11.0	24.0	27.0	30.0
1-1/2	6 x 37	14.0	16.0	15.0	10.0	12.0	13.0	28.0	32.0	35.0
1-5/8	6 x 37	16.0	18.0	21.0	12.0	14.0	15.0	33.0	27.0	41.0
1-3/4	6 x 37	19.0	21.0	24.0	14.0	16.0	18.0	38.0	43.0	48.0
2	6 x 37	25.0	28.0	31.0	18.0	21.0	23.0	49.0	55.0	62.0

HT = Hand Tucked Splice and Hidden Tuck Splice.
For hidden tuck splice (IWRC), use values in HT column.
MS = Mechanical Splice.
S = Swaged or Zinc Poured Socket.

[1] These values only apply when the D/d ratio:
for HT slings is 10 or greater, and
for MS and S Slings is 20 or greater where:
D = Diameter of curvature around which the body of the sling is bent;
d = Diameter of rope.

Table 6.4. Rated Capacities for Single Leg Slings, 6x19 and 6x37 Classification Improved Plow Steel Grade Rope With Independent Wire Rope Core (IWRC).

Rope		Rated Capacities, Tons (2,000 Lb)								
		Vertical			Choker			Vertical Basket[1]		
Dia (Inches)	Constr	HT	MS	S	HT	MS	S	HT	MS	S
1/4	6 x 19	0.53	0.56	0.59	0.40	0.42	0.44	1.0	1.1	1.2
5/16	6 x 19	0.81	0.87	0.92	0.61	0.65	0.69	1.6	1.7	1.8
3/8	6 x 19	1.1	1.2	1.3	0.86	0.93	0.98	2.3	2.5	2.6
7/16	6 x 19	1.5	1.7	1.8	1.2	1.3	1.3	3.1	3.4	3.5
1/2	6 x 19	2.0	2.2	2.3	1.5	1.6	1.7	3.9	4.4	4.6
9/16	6 x 19	2.5	2.7	2.9	1.8	2.1	2.2	4.9	5.5	5.8
5/8	6 x 19	3.0	3.4	3.6	2.2	2.5	2.7	6.0	6.8	7.2
3/4	6 x 19	4.2	4.9	5.1	3.1	3.6	3.8	8.4	9.7	10.0
7/8	6 x 19	5.5	6.6	6.9	4.1	4.9	5.2	11.0	13.0	14.0
1	6 x 19	7.2	8.5	9.0	5.4	6.4	6.7	14.0	17.0	18.0
1-1/8	6 x 19	9.0	10.0	11.0	6.8	7.8	8.5	18.0	21.0	23.0
1-1/4	6 x 37	10.0	12.0	13.0	7.9	9.2	9.9	21.0	24.0	26.0
1-3/8	6 x 37	13.0	15.0	16.0	9.6	11.0	12.0	25.0	29.0	32.0
1-1/2	6 x 37	15.0	17.0	19.0	11.0	13.0	14.0	30.0	35.0	38.0
1-5/8	6 x 37	18.0	20.0	22.0	13.0	15.0	17.0	35.0	41.0	44.0
1-3/4	6 x 37	20.0	24.0	26.0	15.0	18.0	19.0	41.0	47.0	51.0
2	6 x 37	26.0	30.0	33.0	20.0	23.0	25.0	53.0	61.0	66.0

HT = Hand Tucked Splice. For hidden tick splice (IWRC), use values in HT columns.
MS = Mechanical Splice.
S = Swaged or Zinc Poured Socket

[1]These values only apply when the D/d ratio:
for HT slings is 10 or greater, and
for MS and S Slings is 20 or greater where:
D = Diameter of curvature around which the body of the sling is bent;
d = Diameter of rope.

Table 6.5. Rated Capacities for Single Leg Slings, Cable Laid Rope - Mechanical Splice Only, 7x7x7 and 7x19 Construction Galvanized Aircraft Grade Rope, 7x6x19 IWRC Construction Improved Plow Steel Grade Rope.

Rope		Rated Capacities, Tons (2,000 Lb)		
Dia (Inches)	Constr	Vertical	Choker	Vertical Basket[1]
1/4	7 x 7 x 7	0.50	0.38	1.0
3/8	7 x 7 x 7	1.1	0.81	2.0
1/2	7 x 7 x 7	1.8	1.4	3.7
5/8	7 x 7 x 7	2.8	2.1	5.5
3/4	7 x 7 x 7	3.8	2.9	7.6
5/8	7 x 7 x 19	2.9	2.2	5.8
3/4	7 x 7 x 19	4.1	3.0	8.1
7/8	7 x 7 x 19	5.4	4.0	11.0
1	7 x 7 x 19	6.9	5.1	14.0
1-1/8	7 x 7 x 19	8.2	6.2	16.0
1-1/4	7 x 7 x 19	9.9	7.4	20.0
3/4	7 x 6 x 19 IWRC	3.8	2.8	7.6
7/8	7 x 6 x 19 IWRC	5.0	3.8	10.0
1	7 x 6 x 19 IWRC	6.4	4.8	13.0
1-1/8	7 x 6 x 19 IWRC	7.7	5.8	15.0
1-1/4	7 x 6 x 19 IWRC	9.2	6.9	18.0
1-15/16	7 x 6 x 19 IWRC	10.0	7.5	20.0
1-3/8	7 x 6 x 19 IWRC	11.0	8.2	22.0
1-1/2	7 x 6 x 19 IWRC	13.0	9.6	26.0

[1] These values only apply when the D/d ratio is 10 or greater where:
D = Diameter of curvature around which the body of the sling is bent;
d = Diameter of rope.

Table 6.6. Rated Capacities for Single Leg Slings, Part and 6-Part Braided Rope, 6x7 and 6x19 Construction Improved Plow Steel Grade Rope, 7x7 Construction Galvanized Aircraft Grade Rope.

Component Ropes		Rated Capacities, Tons (2,000 Lb)					
Diameter		Vertical		Choker		Basket, Vertical to 30 degrees[1]	
(Inches)	Constr	8-Part	6-Part	8-Part	6-Part	8-Part	6-Part
3/32	6 x 7	0.42	0.32	0.32	0.24	0.74	0.55
1/8	6 x 7	0.75	0.57	0.57	0.42	1.3	0.98
3/16	6 x 7	1.7	1.3	1.3	0.94	2.9	2.2
3/32	7 x 7	0.51	0.39	0.38	0.29	0.89	0.67
1/8	7 x 7	0.95	0.7	0.71	0.53	1.6	1.2
3/16	7 x 7	2.1	1.5	1.5	1.2	3.6	2.7
3/16	6 x 19	1.7	1.3	1.3	0.98	3.0	2.2
1/4	6 x 19	3.1	2.3	2.3	1.7	5.3	4.0
5/16	6 x 19	4.8	3.6	3.6	2.7	8.3	6.2
3/8	6 x 19	6.8	5.1	5.1	3.8	12.0	8.9
7/16	6 x 19	9.3	6.9	6.9	5.2	16.0	12.0
1/2	6 x 19	12.0	9.0	9.0	6.7	21.0	15.0
9/16	6 x 19	15.0	11.0	11.0	8.5	26.0	20.0
5/6	6 x 19	19.0	14.0	14.0	10.0	32.0	24.0
3/4	6 x 19	27.0	20.0	20.0	15.0	46.0	35.0
7/8	6 x 19	36.0	27.0	27.0	20.0	62.0	47.0
1	6 x 19	47.0	35.0	35.0	26.0	81.0	61.0

[1] These values only apply when the D/d rate is 20 or greater where:
D = Diameter of curvature around which the body of the sling is bent
d = Diameter of component rope.

Table 6.7. Rated Capacities for 2-Leg and 3-Leg Bridle Slings, 6x19 and 6x37 Classification Improved Plow Steel Grade Rope With Fiber Core (FC).

(Horizontal angles shown in parentheses.)

Rope		Rated Capacities, Tons (2,000 Lb)											
		2-Leg Bridle Slings						3-Leg Bridle Slings					
Dia (In)	Constr.	30° (60°)		45° Angle		60° (30°)		30° (60°)		45° Angle		60° (30°)	
		HT	MS	HT	MS	HT	MS	HT	MS	HT	MS	HT	MS
1/4	6x19	0.85	0.83	0.70	0.72	0.49	0.51	1.3	1.3	1.0	1.1	0.74	0.76
5/16	6x19	1.3	1.4	1.1	1.1	0.76	0.79	2.0	2.0	1.6	1.7	1.1	1.2
3/8	6x19	1.8	1.9	1.5	1.6	1.1	1.1	2.8	2.9	2.3	2.4	1.6	1.7
7/16	6x19	2.5	2.6	2.0	2.2	1.4	1.5	3.7	4.0	3.0	3.2	2.1	2.3
1/2	6x19	3.2	3.4	2.6	2.8	1.8	2.0	4.8	5.1	3.9	4.2	2.8	3.0
9/16	6x19	4.0	4.3	3.2	3.5	2.3	2.5	6.0	6.5	4.9	5.3	3.4	3.7
5/8	6x19	4.8	5.3	4.0	4.4	2.8	3.1	7.3	8.0	5.9	6.5	4.2	4.6
3/4	6x19	6.8	7.6	5.5	6.2	3.9	4.4	10.0	11.0	8.3	9.3	5.8	6.6
7/8	6x19	8.9	10.0	7.3	8.4	5.1	5.9	13.0	15.0	11.0	13.0	7.7	8.9
1	6x19	11.0	13.0	9.4	11.0	6.7	7.7	17.0	20.0	14.0	16.0	10.0	11.0
1-1/8	6x19	14.0	16.0	12.0	13.0	8.4	9.3	22.0	24.0	18.0	20.0	13.0	14.0
1-1/4	6x37	17.0	19.0	14.0	16.0	9.8	11.0	25.0	29.0	21.0	23.0	15.0	17.0
1-3/8	6x37	20.0	23.0	17.0	19.0	12.0	13.0	31.0	35.0	25.0	28.0	18.0	20.0
1-1/2	6x37	24.0	27.0	20.0	22.0	14.0	16.0	36.0	41.0	30.0	33.0	21.0	24.0
1-5/8	6x37	28.0	32.0	23.0	26.0	16.0	18.0	43.0	48.0	35.0	39.0	25.0	28.0
1-3/4	6x37	33.0	37.0	27.0	30.0	19.0	21.0	49.0	56.0	40.0	45.0	28.0	32.0
2	6x37	43.0	48.0	35.0	39.0	25.0	28.0	64.0	72.0	52.0	59.0	37.0	41.0

HT = Hand Tucked Splice MS - Mechanical Splice

Table 6.8. Rated Capacities for 2-Leg and 3-Leg Bridle Slings, 6x19 and 6x37 Classification Improved Plow Steel Grade Rope With Independent Wire Rope Core (IWRC).

(Horizontal angles shown in parentheses)

Rope		Rated Capacities, Tons (2,000 Lb)											
		2-Leg Bridle Slings						3-Leg Bridle Slings					
Dia (In)	*Constr.*	*30° (60°)*		*45° Angle*		*60° (30°*		*30° (60°)*		*45° Angle*		*60° (30°)*	
		HT	*MS*	*HT*	*MS*	*HT*	*MS*	*HT*	*MS*	*HT*	*MS*	*HT*	*MS*
1/4	6x19	0.92	0.97	0.75	0.79	0.53	0.56	1.4	1.4	1.1	1.2	0.79	0.84
5/16	6x19	1.4	1.5	1.1	1.2	0.81	0.87	2.1	2.3	1.7	1.8	1.2	1.3
3/8	6x19	2.0	2.1	1.6	1.8	1.1	1.2	3.0	3.2	2.4	2.6	1.7	1.9
7/16	6x19	2.7	2.9	2.2	2.4	1.5	1.7	4.0	4.4	3.3	3.6	2.3	2.5
1/2	6x19	3.4	3.8	2.8	3.1	2.0	2.2	5.1	5.7	4.2	4.6	3.0	3.3
9/16	6x19	4.3	4.8	3.5	3.9	2.5	2.7	6.4	7.1	5.2	5.8	3.7	4.1
5/8	6x19	5.2	5.9	4.2	4.8	3.0	3.4	7.8	8.8	6.4	7.2	4.5	5.1
3/4	6x19	7.3	8.4	5.9	6.9	4.2	4.9	11.0	13.0	8.9	10.0	6.3	7.3
7/8	6x19	9.6	11.0	7.8	9.3	5.5	6.6	14.0	17.0	12.0	14.0	8.3	9.9
1	6x19	12.0	15.0	10.0	12.0	7.2	8.5	19.0	22.0	15.0	18.0	11.0	13.0
1-1/8	6x19	16.0	18.0	13.0	15.0	9.0	10.0	23.0	27.0	19.0	22.0	13.0	16.0
1-1/4	6x37	18.0	21.0	15.0	17.0	10.0	12.0	27.0	32.0	22.0	26.0	16.0	18.0
1-3/8	6x37	22.0	25.0	18.0	21.0	13.0	15.0	33.0	38.0	27.0	31.0	19.0	22.0
1-1/2	6x37	26.0	30.0	21.0	25.0	15.0	17.0	39.0	45.0	32.0	37.0	23.0	26.0
1-5/8	6x37	31.0	35.0	25.0	29.0	18.0	20.0	46.0	53.0	38.0	43.0	27.0	31.0
1-3/4	6x37	35.0	41.0	29.0	33.0	20.0	24.0	53.0	61.0	43.0	50.0	31.0	35.0
2	6x37	46.0	53.0	37.0	43.0	26.0	30.0	68.0	79.0	56.0	65.0	40.0	46.0

HT = Hand Tucked Splice. MS = Mechanical Splice

Table 6.9. Rated Capacities for 2-Leg and 3-Leg Bridle Slings, Cable Laid Rope - Mechanical Splice Only, 7x7x7 and 7x7x19 Constructions Galvanized Aircraft Grade Rope, 7x6x19 IWRC Construction Improved Plow Steel Grade Rope.

(Horizontal angles shown in parentheses.)

Rope		Rated capacities, tons (2,000 Lb)					
		2-Leg Bridle sling			3-leg Bridle sling		
Dia (In)	Constr	30° (60°)	45° Angle	60° (30°)	30° (60°)	45° Angle	60° (30°)
1/4	7x7x7	0.87	0.71	0.50	1.3	1.1	0.75
3/8	7x7x7	1.9	1.5	1.1	2.8	2.3	1.6
1/2	7x7x7	3.2	2.6	1.8	4.8	3.9	2.8
5/8	7x7x7	4.8	3.9	2.8	7.2	5.9	4.2
3/4	7x7x7	6.6	5.4	3.8	9.9	8.1	3.7
5/8	7x7x19	5.0	4.1	2.9	7.5	6.1	4.3
3/4	7x7x19	7.0	5.7	4.1	10.0	8.6	6.1
7/8	7x7x19	9.3	7.6	5.4	14.0	11.0	8.1
1	7x7x19	12.0	9.7	6.9	18.0	14.0	10.0
1-1/8	7x7x19	14.0	12.0	8.2	21.0	17.0	12.0
1-1/4	7x7x19	17.0	14.0	9.9	26.0	21.0	15.0
3/4	7x6x19 IWRC	6.6	5.4	3.8	9.9	8.0	5.7
7/8	7x6x19 IWRC	8.7	7.1	5.0	13.0	11.0	7.5
1	7x6x19 IWRC	11.0	9.0	6.4	17.0	13.0	9.6
1-1/8	7x6x19 IWRC	13.0	11.0	7.7	20.0	16.0	11.0
1-1/4	7x6x19 IWRC	16.0	13.0	9.2	24.0	20.0	14.0
1-5/16	7x6x19 IWRC	17.0	14.0	10.0	26.0	21.0	15.0
1-3/8	7x6x19 IWRC	19.0	15.0	11.0	28.0	23.0	16.0
1-1/2	7x6x19 IWRC	22.0	18.0	13.0	33.0	27.0	19.0

Table 6.10. Rated Capacities for 2-Leg and 3-Leg Bridle Slings, 8-Part and 6-Part Braided Rope, 6x7 and 6x19 Construction Improved Plow Steel Grade Rope, 7x7 Construction Galvanized Aircraft Grade Rope.

(Horizontal angles shown in parentheses.)

Rope		Rated capacities, tons (2,000 Lb)											
		2-Leg Bridle slings								3-Leg Bridle slings			
Dia	Constr	30° (60°)		45° angle		60° (30°)		30° (60°)		45° angle		60° (30°)	
(In)		8-Part	6-Part	8-Part	6-Part	8-Part	6-Part	8-Part	6-Part	8-Part	6-Part	8-Part	6-Part
3/32	6x7	.074	.055	0.60	0.45	0.42	0.32	1.1.	0.83	0.90	0.68	0.64	0.48
1/8	6x7	1.3	0.98	1.1	0.80	0.76	0.57	2.0	1.5	1.6	1.2	1.1	0.85
3/16	6x7	2.9	2.2	2.4	1.8	1.7	1.3	4.4	3.3	3.6	2.7	2.5	1.9
3/32	7x7	0.89	0.67	0.72	0.55	0.51	0.39	1.3	1.0	1.1	0.82	0.77	0.58
1/8	7x7	1.6	1.2	1.3	1.0	0.95	0.71	2.5	1.8	2.0	1.5	1.4	1.1
3/16	7x7	3.6	2.7	2.9	2.2	2.1	1.5	5.4	4.0	4.4	3.3	3.1	2.3
3/16	6x19	3.0	2.2	2.4	1.8	1.7	1.3	4.5	3.4	3.7	2.8	2.6	1.9
1/4	6x19	5.3	4.0	4.3	3.2	3.1	2.3	8.0	6.0	6.5	4.9	4.6	3.4
5/16	6x19	8.3	6.2	6.7	5.0	4.8	3.6	12.0	9.3	10.0	7.6	7.1	5.4
3/8	6x19	12.0	8.9	9.7	7.2	6.8	5.1	18.0	13.0	14.0	11.0	10.0	7.7
7/16	6x19	16.0	12.0	13.0	9.8	9.3	6.9	24.0	18.0	20.0	15.0	14.0	10.0
1/2	6x19	21.0	15.0	17.0	13.0	12.0	9.0	31.0	23.0	25.0	19.0	18.0	13.0
9/16	6x19	26.0	20.0	21.0	16.0	15.0	11.0	39.0	29.0	32.0	24.0	23.0	17.0
5/8	6x19	32.0	24.0	26.0	20.0	10.0	14.0	48.0	36.0	40.0	30.0	28.0	21.0
3/4	6x19	46.0	35.0	38.0	28.0	27.0	20.0	69.0	52.0	56.0	42.0	40.0	30.0
7/8	6x19	62.0	47.0	51.0	38.0	36.0	27.0	94.0	70.0	76.0	57.0	54.0	40.0
1	6x19	81.0	61.0	66.0	50.0	47.0	35.0	122.0	91.0	99.0	74.0	70.0	53.0

Table 6.11. Rated Capacities for Strand Laid Grommet - Hand Tucked, Improved Plow Steel Grade Rope.

Rope Body		Rated capacities, tons (2,000 Lb)		
Dia (inches)	Constr	Vertical	Choke	Vertical basket[1]
1/4	7 x 19	0.85	0.64	1.7
5/16	7 x 19	1.3	1.0	2.6
3/8	7 x 19	1.9	1.4	3.8
7/16	7 x 19	2.6	1.9	5.2
1/2	7 x 19	3.3	2.5	6.7
9/16	7 x 19	4.2	3.1	8.4
5/8	7 x 19	5.2	3.9	10.0
3/4	7 x 19	7.4	5.6	15.0
7/8	7 x 19	10.0	7.5	20.0
1	7 x 19	13.0	9.7	26.0
1-1/8	7 x 19	16.0	12.0	32.0
1-1/4	7 x 37	18.0	14.0	37.0
1-3/8	7 x 37	22.0	16.0	44.0
1-1/2	7 x 37	26.0	19.0	52.0

[1] These values only apply when the D/d ratio is 5 or greater where:
D = Diameter of curvature around which rope is bent;
d = Diameter of rope body.

Table 6.12. Rated Capacities for Cable Laid Grommet - Hand Tucked, 7x6x7 and 7x6x19 Constructions Improved Plow Steel Grade Rope, 7x7x7 Construction Galvanized Aircraft Grade Rope.

Cable Body		Rated capacities, tons (2,000 Lb)		
Dia (inches)	Constr	Vertical	Choker	Vertical basket[1]
3/8	7x6x7	1.3	0.95	2.5
9/16	7x6x7	2.8	2.1	5.6
5/8	7x6x7	3.8	2.8	7.6
3/8	7x7x7	1.6	1.2	3.2
9/16	7x7x7	3.5	2.6	6.9
5/8	7x7x7	4.5	3.4	9.0
5/8	7x6x19	3.9	3.0	7.9
3/4	7x6x19	5.1	3.8	10.0
15/16	7x6x19	7.9	5.9	16.0
1-1/8	7x6x19	11.0	8.4	22.0
1-5/16	7x6x19	15.0	11.0	30.0
1-1/2	7x6x19	19.0	14.0	39.0
1-11/16	7x6x19	24.0	18.0	49.0
1-7/8	7x6x19	30.0	22.0	60.0
2-1/4	7x6x19	42.0	31.0	84.0
2-5/8	7x6x19	56.0	42.0	112.0

[1] These values only apply when the D/d ratio is 5 or greater where:
D = Diameter of curvature around which cable body is bent;
d = Diameter of cable body.

Table 6.13. Rated Capacities for Strand Laid Endless Slings - Mechanical Joint, Improved Plow Steel Grade Rope.

Rope Body		Rated capacities, tons (2,000 Lb)		
Dia (inches)	Constr	Vertical	Choker	Vertical basket[1]
1/4	6 x 19 IWRC	0.92	0.69	1.8
3/8	6 x 19 IWRC	2.0	1.5	4.1
1/2	6 x 19 IWRC	3.6	2.7	7.2
5/8	6 x 19 IWRC	5.6	4.2	11.0
3/4	6 x 19 IWRC	8.0	6.0	16.0
7/8	6 x 19 IWRC	11.0	8.1	21.0
1	6 x 19 IWRC	14.0	10.0	28.0
1-1/8	6 x 19 IWRC	18.0	13.0	35.0
1-1/4	6 x 37 IWRC	21.0	15.0	41.0
1-3/8	6 x 37 IWRC	25.0	19.0	50.0
1-1/2	6 x 37 IWRC	29.0	22.0	59.0

[1] These values only apply when the D/d ratio is 5 or greater where:
D = Diameter of curvature around which rope is bent;
d = Diameter of rope body.

Table 6.14. Cable Laid Endless Slings - Mechanical Joint, 7x7x7 and 7x7x19 Construction Galvanized Aircraft Grade Rope, 7x6x19 IWRC Construction Improved Plow Steel Grade Rope.

Cable body		Rated capacities, tons (2,000 Lb)		
Vertical Dia (inches)	Constr	Vertical	Choker	basket [1]
1/4	7x7x7	0.83	0.62	1.6
3/8	7x7x7	1.8	1.3	3.5
1/2	7x7x7	3.0	2.3	6.1
5/8	7x7x7	4.5	3.4	9.1
3/4	7x7x7	6.3	4.7	12.0
5/8	7x7x19	4.7	3.5	9.5
3/4	7x7x19	6.7	5.0	13.0
7/8	7x7x19	8.9	6.6	18.0
1	7x7x19	11.0	8.5	22.0
1-1/8	7x7x19	14.0	10.0	28.0
1-1/4	7x7x19	17.0	12.0	33.0
3/4	7x6x19 IWRC	6.2	4.7	12.0
7/8	7x6x19 IWRC	8.3	6.2	16.0
1	7x6x19 IWRC	10.0	7.9	21.0
1-1/8	7x6x19 IWRC	13.0	9.7	26.0
1-1/4	7x6x19 IWRC	16.0	12.0	31.0
1-3/8	7x6x19 IWRC	18.0	14.0	37.0
1-1/2	7x6x19 IWRC	22.0	16.0	43.0

[1]These values only apply when the D/d value is 5 or greater where:
D = Diameter of curvature around which cable body is bent;
d = Diameter of cable body.

Table 6.15. Rated Capacities Carbon Steel and Stainless Steel Metal Mesh Slings.

(Horizontal angles shown in parentheses)

Sling width in inches	Vertical or choker	Vertical basket	Effect of angle on rated capacities in basket hitch		
			30° (60°)	45° (45°)	60° (30°)
Heavy Duty - 10 Ga 35 Spirals/Ft of sling width					
2	1,500	3,000	2,600	2,100	1,500
3	2,700	5,400	4,700	3,800	2,700
4	4,000	8,000	6,900	5,600	4,000
6	6,000	12,000	10,400	8,400	6,000
8	8,000	16,000	13,800	11,300	8,000
10	10,000	20,000	17,000	14,100	10,000
12	12,000	24,000	20,700	16,900	12,000
14	14,000	28,000	24,200	19,700	14,000
16	16,000	32,000	27,700	22,600	16,000
18	18,000	36,000	31,100	25,400	18,000
20	20,000	40,000	34,600	28,200	20,000
Medium Duty - 12 Ga 43 Spirals/Ft of sling width					
2	1,350	2,700	2,300	1,900	1,400
3	2,000	4,000	3,500	2,800	2,000
4	2,700	5,400	4,700	3,800	2,700
6	4,500	9,000	7,800	6,400	4,500
8	6,000	12,000	10,400	8,500	6,000
10	7,500	15,000	13,000	10,600	7,500
12	9,000	18,000	15,600	12,700	9,000
14	10,500	21,000	18,200	14,800	10,500
16	12,000	24,000	20,800	17,000	12,000
18	13,500	27,000	23,400	19,100	13,500
20	15,000	30,000	26,000	21,200	15,000
Light Duty - 14 Ga 59 Spirals/Ft of sling width					
2	900	1,800	1,600	1,300	900
3	1,400	2,800	2,400	2,000	1,400
4	2,000	4,000	3,500	2,800	2,000
6	3,000	6,000	5,200	4,200	3,000
8	4,000	8,000	6,900	5,700	4,000
10	5,000	10,000	8,600	7,100	5,000
12	6,000	12,000	10,400	8,500	6,000
14	7,000	14,000	12,100	9,900	7,000
16	8,000	16,000	13,900	11,300	8,000
18	9,000	18,000	15,600	12,700	9,000
20	10,000	20,000	17,300	14,100	10,000

Table 6.16. Manilla Rope Slings.

(Angle of rope to vertical shown in parentheses)

Rope dia. nominal in inches	Nominal wt. per 100 ft in pounds	Eye and eye sling						Endless sling					
		Vertical hitch	Choker hitch	Basket hitch; Angle of rope to horizontal				Vertical hitch	Choker hitch	Basket hitch; Angle of rope to horizontal			
				90° (0°)	60° (30°)	45° (45°)	30° (60°)			90° (0°)	60° (30°)	45° (45°)	30° (60°)
1/2	7.5	480	240	960	830	680	480	865	430	1,730	1,500	1,220	865
9/16	10.4	620	310	1,240	1,070	875	620	1,120	560	2,230	1,930	1,580	1,120
5/8	13.3	790	395	1,580	1,370	1,120	790	1,420	710	2,840	2,460	2,010	1,420
3/4	16.7	970	485	1,940	1,680	1,370	970	1,750	875	3,490	3,020	2,470	1,750
13/16	19.5	1,170	585	2,340	2,030	1,650	1,170	2,110	1,050	4,210	3,650	2,980	2,110
7/8	22.5	1,390	695	2,780	2,410	1,970	1,390	2,500	1,250	5,000	4,330	3,540	2,500
1	27.0	1,620	810	3,240	2,810	2,290	1,620	2,920	1,460	5,830	5,050	4,120	2,920
1-1/16	31.3	1,890	945	3,780	3,270	2,670	1,890	3,400	1,700	6,800	5,890	4,810	3,400
1-1/8	36.0	2,160	1,080	4,320	3,740	3,050	2,160	3,890	1,940	7,780	6,730	5,500	3,890
1-1/4	41.7	2,430	1,220	4,860	4,210	3,440	2,430	4,370	2,190	8,750	7,580	6,190	4,370
1-5/16	47.9	2,700	1,350	5,400	4,680	3,820	2,700	4,860	2,430	9,720	8,420	6,870	4,860
1-1/2	59.9	3,330	1,670	6,600	5,770	4,710	3,330	5,990	3,000	12,000	10,400	8,480	5,990
1-5/8	74.6	4,050	2,030	8,100	7,010	5,730	4,050	7,290	3,650	14,600	12,600	10,300	7,290
1-3/4	89.3	4,770	2,390	9,540	8,260	6,740	4,770	8,590	4,290	17,200	14,900	12,100	8,590
2	107.5	5,580	2,790	11,200	9,660	7,890	5,580	10,000	5,020	20,100	17,400	14,200	10,000
2-1/8	125.0	6,480	3,240	13,000	11,200	9,160	6,480	11,700	5,830	23,300	20,200	16,500	11,700
2-1/4	146.0	7,380	3,690	14,800	12,800	10,400	7,380	13,300	6,640	26,600	23,000	18,800	13,300
2-1/2	166.7	8,370	4,190	16,700	14,500	11,800	8,370	15,100	7,530	30,100	26,100	21,300	15,100
2-5/8	190.8	9,360	4,680	18,700	16,200	13,200	9,360	16,800	8,420	33,700	29,200	23,800	16,800

See Figures 6-1 and 6-2 for sling configuration descriptions.

Table 6.17. Nylon Rope Slings.

(Angle of rope to vertical shown in parentheses)

Rope dia. in inches	Nominal wt. per 100 ft in pounds	Eye and Eye Sling						Endless Sling					
		Vertical hitch	Choker hitch	Basket hitch; Angle of rope to horizontal				Vertical hitch	Choker hitch	Basket hitch; Angle of rope to horizontal			
				90° (0°)	60° (30°)	45° (45°)	30° (60°)			90° (0°)	60° (30°)	45° (45°)	30° (60°)
1/2	6.5	635	320	1,270	1,100	900	635	1,140	570	2,290	1,980	1,620	1,140
9/16	8.3	790	395	1,580	1,370	1,120	790	1,420	710	2,840	2,460	2,010	1,420
5/8	10.5	1,030	515	2,060	1,780	1,460	1,030	1,850	925	3,710	3,210	2,620	1,850
3/4	14.5	1,410	705	2,820	2,440	1,990	1,410	2,540	1,270	5,080	4,400	3,590	2,540
13/16	17.0	1,680	840	3,360	2,910	2,380	1,680	3,020	1,510	6,050	5,240	4,280	3,020
7/8	20.0	1,980	990	3,960	3,430	2,800	1,980	3,560	1,780	7,130	6,170	5,040	3,560
1	26.0	2,480	1,240	4,960	4,300	3,510	2,480	4,460	2,230	8,930	7,730	6,310	4,460
1-1/16	29.0	2,850	1,430	5,700	4,940	4,030	2,850	5,130	2,570	10,300	8,890	7,260	5,130
1-1/8	34.0	3,270	1,640	6,540	5,660	4,620	3,270	5,890	2,940	11,800	10,200	8,330	5,890
1-1/4	40.0	3,710	1,860	7,420	6,430	5,250	3,710	6,680	3,340	13,400	11,600	9,450	6,680
1-5/16	45.0	4,260	2,130	8,520	7,380	6,020	4,260	7,670	3,830	15,300	13,300	10,800	7,670
1-1/2	55.0	5,250	2,630	10,500	9,090	7,420	5,250	9,450	4,730	18,900	16,400	13,400	9,450
1-5/8	68.0	6,440	3,220	12,900	11,200	9,110	6,440	11,600	5,800	23,200	20,100	16,400	11,600
1-3/4	83.0	7,720	3,860	15,400	13,400	10,900	7,720	13,900	6,950	27,800	24,100	19,700	13,900
2	95.0	9,110	4,560	18,200	15,800	12,900	9,110	16,400	8,200	32,800	28,400	23,200	16,400
2-1/8	109.0	10,500	5,250	21,000	18,200	14,800	10,500	18,900	9,450	37,800	32,700	26,700	18,900
2-1/4	129.0	12,400	6,200	24,800	21,500	17,500	12,400	22,300	11,200	44,600	38,700	31,600	22,300
2-1/2	149.0	13,900	6,950	27,800	24,100	19,700	13,900	25,000	12,500	50,000	43,300	35,400	25,000
2-5/8	168.0	16,000	8,000	32,000	27,700	22,600	16,000	28,800	14,400	57,600	49,900	40,700	28,800

See Figures 6-1 and 6-2 for sling configuration descriptions.

Table 6.18. Polyester Rope Slings.

(Angle of rope to vertical shown in parentheses)

Rope dia. nominal in inches	Nominal wt. per 100 ft in pounds	Vertical hitch	Eye and eye sling: Choker hitch	Eye and eye sling: Basket hitch; Angle of rope to horizontal: 90° (0°)	60° (30°)	45° (45°)	30° (60°)	Endless sling: Vertical hitch	Choker hitch	Basket hitch; Angle of rope to horizontal: 90° (0°)	60° (30°)	45° (45°)	30° (60°)
1/2	8.0	635	320	1,270	1,100	900	635	1,140	570	2,290	1,980	1,620	1,140
9/16	10.2	790	395	1,580	1,370	1,120	790	1,420	710	2,840	2,460	2,010	1,420
5/8	13.0	990	495	1,980	1,710	1,400	990	1,780	890	3,570	3,090	2,520	1,780
3/4	17.5	1,240	620	2,480	2,150	1,750	1,240	2,230	1,120	4,470	3,870	3,160	2,230
13/16	21.0	1,540	770	3,080	2,670	2,180	1,540	2,770	1,390	5,540	4,800	3,920	2,770
7/8	25.0	1,780	890	3,560	3,080	2,520	1,780	3,200	1,600	6,410	5,550	4,530	3,200
1	30.5	2,180	1,090	4,360	3,780	3,080	2,180	3,920	2,960	7,850	6,800	5,550	3,920
1-1/16	34.5	2,530	1,270	5,060	4,380	3,580	2,530	4,550	2,280	9,110	7,990	6,440	4,550
1-1/8	40.0	2,920	1,460	5,840	5,060	4,130	2,920	5,260	2,630	10,500	9,100	7,440	5,260
1-1/4	46.3	3,290	1,650	6,580	5,700	4,650	3,290	5,920	2,960	11,800	10,300	8,380	5,920
1-5/16	52.5	3,710	1,860	7,420	6,430	5,250	3,710	6,680	3,340	13,400	11,600	9,450	6,680
1-1/2	66.8	4,630	2,320	9,260	8,020	6,550	4,630	8,330	4,170	16,700	14,400	11,800	8,330
1-5/8	82.0	5,640	2,820	11,300	9,770	7,980	5,640	10,200	5,080	20,300	17,600	14,400	10,200
1-3/4	98.0	6,710	3,360	13,400	11,600	9,490	6,710	12,100	6,040	24,200	20,900	17,100	12,100
2	118.0	7,920	3,960	15,800	13,700	11,200	7,920	14,300	7,130	28,500	24,700	20,200	14,300
2-1/8	135.0	9,110	4,460	18,200	15,800	12,900	9,110	16,400	8,200	32,800	28,400	23,200	16,400
2-1/4	157.0	10,600	5,300	21,200	18,400	15,000	10,600	19,100	9,540	38,200	33,100	27,000	19,100
2-1/2	181.0	12,100	6,050	24,200	21,000	17,100	12,100	21,800	10,900	43,600	37,700	30,800	21,800
2-5/8	205.0	13,600	6,800	27,200	23,600	19,200	13,600	24,500	12,200	49,000	42,400	34,600	24,500

See Figures 6-1 and 6-2 for sling configuration descriptions.

Table 6.19. Polypropylene Rope Slings.

(Angle of rope to vertical shown in parentheses)

Rope dia. nominal in inches	Nominal wt. per 100 ft in pounds	Eye and eye sling							Endless sling				
		Vertical hitch	Choker hitch	Basket hitch; Angle of rope to horizontal				Vertical hitch	Choker hitch	Basket hitch; Angle of rope to horizontal			
				90° (0°)	60° (30°)	45° (45°)	30° (60°)			90° (0°)	60° (30°)	45° (45°)	30° (60°)
1/2	4.7	645	325	1,290	1,120	910	645	1,160	580	2,320	2,010	1,640	1,160
9/16	6.1	780	390	1,560	1,350	1,100	780	1,400	700	2,810	2,430	1,990	1,400
5/8	7.5	950	475	1,900	1,650	1,340	950	1,710	855	3,420	2,960	2,420	1,710
3/4	10.7	1,300	650	2,600	2,250	1,840	1,300	2,340	1,170	4,680	4,050	3,310	2,340
13/16	12.7	1,520	760	3,040	2,630	2,150	1,520	2,740	1,370	5,470	4,740	3,870	2,740
7/8	15,0	1,760	880	3,520	3,050	2,490	1,760	3,170	1,580	6,340	5,490	4,480	3,170
1	18.0	2,140	1,070	4,280	3,700	3,030	2,140	3,850	1,930	7,700	6,670	5,450	3,860
1-1/16	20.4	2,450	1,230	4,900	4,240	3,460	2,450	4,410	2,210	8,820	7,640	6,240	4,410
1-1/8	23.7	2,800	1,400	5,600	4,850	3,960	2,800	5,040	2,520	10,100	8,730	7,130	5,040
1-1/4	27.0	3,210	1,610	6,420	5,560	4,540	3,210	5,780	2,890	11,600	10,000	8,170	5,780
1-5/16	30.5	3,600	1,800	7,200	6,240	5,090	3,600	6,480	3,240	13,000	11,200	9,170	6,480
1-1/2	38.5	4,540	2,270	9,080	7,860	6,420	4,540	8,170	4,090	16,300	14,200	11,600	8,170
1-5/8	47.5	5,510	2,760	11,000	9,540	7,790	5,510	9,920	4,960	19,800	17,200	14,000	9,920
1-3/4	57.0	6,580	3,290	13,200	11,400	9,300	6,580	11,800	5,920	23,700	20,500	16,800	11,800
2	69.0	7,960	3,980	15,900	13,800	11,300	7,960	14,300	7,160	28,700	24,800	20,300	14,300
2-1/8	80.0	9,330	4,670	18,700	16,200	13,200	9,330	16,800	8,400	33,600	29,100	23,800	16,800
2-1/4	92.0	10,600	5,300	21,200	18,400	15,000	10,600	19,100	9,540	38,200	33,100	27,000	19,100
2-1/2	107.0	12,200	6,100	24,400	21,100	17,300	12,200	22,000	11,000	43,900	38,000	31,100	22,000
2-5/8	120.0	13,800	6,900	27,600	23,900	19,600	13,800	24,800	12,400	49,700	43,000	35,100	24,800

See Figures 6-1 and 6-2 for sling configuration descriptions.

Table 6.20. Synthetic Web Slings - 1,000 Pounds Per Inch of Width - Single Ply.

(rated capacity in pounds)

Sling Body width inches		Triangle — Choker slings, type 1: Triangle — Triangle slings, type II: Eye and eye with flat eye slings, type III: Eye and eye with twisted slings, type IV					Endless Slings, type V						Return eye slings, type VI					
	Vert	Choker	Vert Basket	30° Basket	45° Basket	60° Basket	Vert	Choker	Vert Basket	30° Basket	45° Basket	60° Basket	Vert	Choker	Vert Basket	30° Basket	45° Basket	60° Basket
1	1,000	750	2,000	1,700	1,400	1,000	1,600	1,300	3,200	2,800	2,300	1,600	800	650	1,600	1,400	1,150	800
2	2,000	1,500	4,000	3,500	2,800	2,000	3,200	2,600	6,400	5,500	4,500	3,200	1,600	1,300	3,200	2,800	2,300	1,600
3	3,000	2,200	6,000	5,200	4,200	3,000	4,800	3,800	9,600	8,300	6,800	4,800	2,400	1,950	4,800	4,150	3,400	2,400
4	4,000	3,000	8,000	6,900	5,700	4,000	6,400	5,100	12,800	11,100	9,000	6,400	3,200	2,600	6,400	5,500	4,500	3,200
5	5,000	3,700	10,000	8,700	7,100	5,000	8.000	6,400	16,000	13,900	11,300	8,000	4,000	3,250	8,000	6,900	5,650	4,000
6	6,000	4,500	12,000	10,400	8,500	6,000	9,600	7,700	19,200	16,600	13,600	9,600	4,800	3,800	9,600	8,300	6,800	4,600

NOTES: 1. All angles shown are measured from the vertical.

2. Capacities for intermediate widths not shown may be obtained by interpolation.

Table 6.21. Synthetic Web Slings - 1,200 Pounds Per Inch of Width - Single Ply.

(rated capacity in pounds)

Sling Body width inches	Triangle — Choker slings, type 1: Triangle — Triangle slings, type II: Eye and eye with flat eye slings, type III: Eye and eye with twisted slings, type IV						Endless Slings, type V						Return eye slings, type VI					
	Vert	Choker	Vert Basket	30° Basket	45° Basket	60° Basket	Vert	Choker	Vert Basket	30° Basket	45° Basket	60° Basket	Vert	Choker	Vert Basket	30° Basket	45° Basket	60° Basket
1	1,200	900	2,400	2,100	1,700	1,200	1,900	1,500	3,800	3,300	2,700	1,900	950	750	1,900	1,650	1,350	950
2	2,400	1,800	4,800	4,200	3,400	2,400	3,800	3,000	7,600	6,600	5,400	3,800	1,900	1,500	3,800	3,300	2,700	1,900
3	3,600	2,700	7,200	6,200	5,100	3,600	5,800	4,600	11,600	10,000	8,200	5,800	2,850	2,250	5,700	4,950	4,050	2,850
4	4,800	3,600	9,600	8,300	6,800	4,800	7,700	6,200	15,400	13,300	10,900	7,700	3,800	3,000	7,600	6,600	5,400	3,800
5	6,000	4,500	12,000	10,400	8,500	6,000	9,600	7,700	19,200	16,600	13,600	9,600	4,750	3,750	9,500	8,250	6,750	4,750
6	7,200	5,400	14,400	12,500	10,200	7,200	11,500	9,200	23,000	19,900	16,300	11,500	5,800	4,600	11,600	10,000	8,200	5,800

NOTES: 1. All angles shown are measured from the vertical.

2. Capacities for intermediate widths not shown may be obtained by interpolation.

Table 6.22. Synthetic Web Slings - 1,600 Pounds Per Inch of Width - Single Ply.

(rated capacity in pounds)

Sling Body width inches	Triangle — Choker slings, type 1: Triangle — Triangle slings, type II: Eye and eye with flat eye slings, type III: Eye and eye with twisted slings, type IV						Endless Slings, type V						Return eye slings, type VI					
	Vert	Choker	Vert Basket	30° Basket	45° Basket	60° Basket	Vert	Choker	Vert Basket	30° Basket	45° Basket	60° Basket	Vert	Choker	Vert Basket	30° Basket	45° Basket	60° Basket
1	1,600	1,200	3,200	2,800	2,300	1,600	2,600	2,100	5,200	4,500	3,700	2,600	1,050	1,050	2,600	2,250	1,850	1,300
2	3,200	2,400	6,400	5,500	4,500	3,200	5,100	4,100	10,200	8,800	7,200	5,100	2,600	2,100	5,200	4,500	3,700	2,600
3	4,800	3,600	9,600	8,300	6,800	4,800	7,700	6,200	15,400	13,300	10,900	7,700	3,900	3,150	7,800	6,750	5,500	3,900
4	6,400	4,800	12,800	11,100	9,000	6,400	10,100	8,200	20,400	17,700	14,400	10,200	5,100	4,100	10,200	8,800	7,200	5,100
5	8,000	6,000	16,000	13,800	11,300	8,000	12,800	10,200	25,600	22,200	18,100	12,800	6,400	5,150	12,800	11,050	9,050	6,400
6	9,600	7,200	19,200	16,600	13,600	9,600	15,400	12,300	30,800	26,700	21,800	15,400	7,700	6,200	15,400	13,300	10,900	7,700

NOTES: 1. All angles shown are measured from the vertical.

2. Capacities for intermediate widths not shown may be obtained by interpolation.

Chapter 7

OVERHEAD, GANTRY, UNDERHUNG CRANES, AND MONORAIL SYSTEMS

7.1. Hazards and (or) Human Factors:

7.1.1. The most serious injury potential associated with the cranes and monorails described in this chapter are caused by permitting the loads to contact personnel. Bruises, lacerations, pinching, and fractures are associated with loading, unloading, and load transporting operations.

7.1.2. Injuries and property damage are caused by striking personnel or objects with moving loads, personnel falling from equipment, and dropping or slipping loads. Injury severity is increased by personnel not wearing required PPE, such as hard hat, gloves, safety-toe shoes, and eye protection.

7.1.3. Serious hazards are overloading, obstruction to free passage of the load, misuse of equipment, and dropping, or slipping of the load caused by improper hitching or slinging.

7.1.4. Where feasible, safeguards have been built in to minimize the probability for human error but, hazards that cannot be met by mechanical means still exist; for example, moving ropes, incomplete guarding which design alone prevents, and being caught between exposed parts.

7.1.5. Some mishap cause factors are: inadvertent movement of equipment or loads; failure to use available safety devices such as brakes, locks, and warning signals; failure to detect equipment deficiencies or malfunction; acceptance of "minor" deficiencies; and deviation from approved procedures.

7.1.6. Lack of proper supervision and a lack of correct and adequate communication leads to poor, uncoordinated operations of cranes which, in turn, will increase the mishap potential.

7.1.7. Visual acuity, depth perception, color blindness, poor hearing, epilepsy, or heart condition may result in poor coordinated control techniques. This may be brought about when operators cannot distinguish the color of warning lights and required meanings and cannot relate equipment and load proximity because of poor acuity and (or) depth perception (refer to paragraph **7.2.3.**.). Good physical condition is essential to ensure uninterrupted control and safe operations.

7.1.8. Positive supervision and competent operators and qualified maintenance personnel are essential factors for safe operations of crane and (or) hoisting equipment.

7.2. Requirements:

7.2.1. Acquisition:

7.2.1.1. All new overhead and gantry cranes constructed and installed on or after 31 August 1971 will meet the design specifications of ANSI/ASME Standards B30.2, Overhead and Gantry Cranes (Top Running Bridge, Multiple Girders), and B30.11, Monorails and Underhung Cranes. Cranes constructed before 31 August 1971 will be modified to conform to those design specifications, unless it can be shown the crane cannot feasibly or economically be altered and it substantially complies with the requirements of this standard. Contracts for procurement of overhead and gantry cranes shall mandate CMAA 70 or 74, as applicable, and each of the appropriate ANSI/ASME B30 series standards as compliance documents. Nuclear certified hoists must meet requirements in AFMAN 91-118.

7.2.1.2. Hazards shall be identified by conducting System Safety Analysis as defined in Mil Std 882 or commercial equivalent. The procuring activity shall specify the required analyses (such as preliminary hazard analysis or operating hazard analysis). The results of these analyses shall be included in applicable documents.

7.2.2. General:

7.2.2.1. Cranes may be modified and rerated, if the modifications and the supporting structures are checked thoroughly for the new rated load by a qualified engineer or the equipment manufacturer. The crane shall be tested according to paragraph **7.2.5.** The new rated load shall be displayed on the crane or hoist.

7.2.2.2. The rated load of the crane shall be plainly marked on each side of the crane. If the crane has more than one hoisting unit, each unit shall have its rated load marked on it or its load block and this marking shall be clearly visible from the floor or ground.

7.2.2.3. A minimum clearance of 3 inches overhead and 2 inches laterally shall be maintained between crane and obstructions.

7.2.2.4. Where passageways or walkways are provided, obstructions shall not be placed so the safety of personnel will be jeopardized by movements of the crane.

7.2.2.5. Only properly trained and qualified personnel shall be permitted to operate a crane.

7.2.2.6. The general arrangement of the cab and the location of control and protective equipment shall be such that all operating handles are within convenient reach of the operator when facing the area to be served by the load hook or while facing the direction of travel of the cab. The arrangement shall allow the operator a full view of the load hook in all positions.

7.2.2.7. Pendant and cab hoist controls for trolley and bridge movement shall use compass points (north, south, east, and west) as the preferred identification whenever possible.

7.2.2.8. Hoists utilizing synchronous controls for multiple point lifting movements shall be of fail safe design to preclude inadvertent operation which may be caused by malfunctions of selector switches, power failure, or improper sequencing of controls.

7.2.2.9. Access to the cab or bridge walkway shall be by a conveniently placed fixed ladder, stairs, or platform requiring no step over any gap exceeding 3 inches. Fixed ladders shall be designed and installed according to ANSI A14.3, Safety Requirements for Fixed Ladders, and 29 CFR 1910.27, Fixed Ladders. See AFOSH Standard 127-22, Walking Surfaces, Guarding Floor and Wall Openings and Holes, Fixed Industrial Stairs, and Portable and Fixed Ladders.

7.2.2.10. A carbon dioxide or dry chemical (or equivalent) at least 10 BC rated, hand fire extinguisher shall be kept in the cab.

7.2.2.11. Pendant control boxes and fixed control stations shall be constructed to prevent electrical shock and be clearly marked for identification of functions and be legible.

7.2.2.12. Except for floor-operated cranes, a gong, buzzer, or other effective warning signal shall be provided for each crane equipped with a power traveling mechanism.

7.2.2.13. The hoisting motion of all electric traveling cranes shall be provided with an overtravel limit switch in the hoisting direction.

7.2.2.14. Emergency descent means shall be provided on all crane cabs. Rope hand line is not acceptable. Only approved control descent devices shall be used.

7.2.2.15. Crane operators shall not be placed in a situation where there is a high probability that danger to life, health, or safety may suddenly develop.

7.2.2.16. Lift eyes and (or) lift points used for the attachment of slings, clevis, shackles, or hooks shall be constructed of forged or alloy steel. Rebar steel shall not be permitted as attach points for any load.

7.2.2.17. Refer to **Chapter 9** for information on hoisting equipment (sheaves, ropes, and equalizers).

7.2.3. Qualification of Operators:

7.2.3.1. Cab-Operated and Pulpit-Operated Equipment (also see paragraph **5.2.3.1.3.**)

7.2.3.1.1. Operators performing these duties will be qualified by either military and (or) Air Force specialty training or be able to furnish satisfactory evidence of prior qualification and experience. Qualification will be limited to the specific type equipment for which examined.

7.2.3.1.2. Operators shall meet the following minimum physical qualifications:

7.2.3.1.2.1. Have vision of at least 20/30 Snellen in one eye, and 20/50 in the other, with or without glasses.

7.2.3.1.2.2. Be able to distinguish red, green, and yellow, regardless of position of colors.

7.2.3.1.2.3. Test for ordinary conversation in one ear, with or without a hearing aid to ensure there is adequate hearing for a specific operation.

7.2.3.1.2.4. Evidence of physical defect, or emotional instability which could render the operator a hazard to himself or others, or which in the opinion of the examiner or supervisor could interfere with the operator's safe performance, may be sufficient cause for disqualification. In such cases specialized clinical or medical judgments and tests may be required. ***Note: A history of epilepsy or a disabling heart condition may be sufficient reason for disqualification.***

7.2.3.1.3. Potential operator trainees will have good depth perception, field of vision, reaction time, manual dexterity or coordination, and no tendencies to dizziness or similar undesirable characteristics. Physical defects such as loss of arm, hand, leg, foot, or gross loss of function thereof will be considered as cause for denial of acceptance into an entry level training program for operators.

7.2.3.2. Floor-Operated Equipment:

7.2.3.2.1. Supervision will require personnel pass a practical operating examination administered by a qualified operator and (or) instructor.

7.2.3.2.2. Qualification will be limited to the specific type of equipment for which examined.

7.2.4. Operations

7.2.4.1. Cab-Operated and Pulpit-Operated Equipment:

7.2.4.1.1. Equipment will be operated only by the following personnel:

7.2.4.1.1.1. Designated operators.

7.2.4.1.1.2. Trainees under the direct supervision of a designated operator.

7.2.4.1.1.3. Maintenance and test personnel, when it is necessary in the performance of their duties.

7.2.4.1.1.4. Inspectors.

7.2.4.1.2. No one, other than personnel specified above will enter a cab or pulpit, with the exception of persons such as oilers and supervisors whose duties require them to do so, and then only in the performance of their duties and with the knowledge of the operator or other appointed person.

7.2.4.2. Floor-Operated Equipment. Equipment will be operated by the following personnel:

7.2.4.2.1. Designated personnel.

7.2.4.2.2. Inspectors.

7.2.4.2.3. Maintenance and test personnel, when it is necessary in the performance of their duties.

7.2.4.3. Remote-Operated or Automatic Equipment. The use of remote control or automatic equipment involves such a wide variety of service requirements and conditions that each installation will be carefully analyzed and the operation reviewed at least monthly for the first 6 months of operation to determine whether paragraph **7.2.4.1.** or **7.2.4.2.** will apply.

7.2.4.4. Operating Practices:

7.2.4.4.1. While actually engaged in operating the equipment the operator will not divert their attention.

7.2.4.4.2. An operator will not engage in the operation of equipment when he or she is physically or mentally unfit.

7.2.4.4.3. The operator will respond to signals only from the person who is directing the lift or a designated signal person, but will obey a stop signal at all times.

7.2.4.4.4. Each operator will be held directly responsible for the safe operation of the equipment. Whenever there is any doubt as to safety, the operator will have the authority to stop and refuse to handle loads until safety has been ensured.

7.2.4.4.5. A warning signal, if required, will be sounded each time before traveling and intermittently during travel, particularly when approaching personnel.

7.2.4.4.6. Before leaving the equipment unattended, the operator will lower the load to the ground, place controls in the "off" position, and open the main line switch of the specific equipment (if either cab or pulpit-operated).

7.2.4.4.7. If the operator finds the main or emergency switch open (off) when starting on duty, he or she will not close it (turn it on) until making certain no one is on or about the equipment. If there is a warning tag on the main switch or the switch is locked out, only the supervisor or person placing the tag or lock will remove it. (See AFOSH Standard 127-45.)

7.2.4.4.8. Before closing the main switch, the operator will make certain all controllers are in the "off" position.

7.2.4.4.9. If power goes off during operation, the operator will immediately throw all controllers to the "off" position.

7.2.4.4.10. The operator will be familiar with the equipment and its proper care. If adjustments or repairs are necessary (or any damage is observed) the operator will report it promptly to the appointed person and will also notify the next operator of the deficiencies upon changing shifts. The results of the above shall be carefully recorded in the logbook, in full detail, and shall be dated and signed.

7.2.4.4.11. Contacts with stops or other equipment will be made with extreme caution and only after all persons on or below equipment are aware of the action.

7.2.4.4.12. Before departing the work area, operators of outdoor cranes will secure them to prevent inadvertent movement.

7.2.4.4.13. When the wind-indicating alarm is given, the bridge on the outside cranes will be anchored.

7.2.4.4.14. Before performing any maintenance work on the equipment, the operator and (or) maintainer will lock the main switch in the open position.

7.2.4.4.15. All controls will be tested by the operator when beginning a new shift except when an operation is in progress. If any controls do not operate properly, they will be adjusted or repaired before operations begin.

7.2.4.5. Handling the Load:

7.2.4.5.1. The equipment shall not be loaded beyond its rated load capacity except for test purposes as provided in paragraph **7.2.5.6.**

7.2.4.5.2. When attaching the load, ensure:

7.2.4.5.2.1. The hoist chain or hoist rope is free from kinks or twists and is not wrapped around the load.

7.2.4.5.2.2. The load is attached to the load hook by means of slings or other approved devices.

7.2.4.5.2.3. Care is taken to ensure the sling clears all obstacles.

7.2.4.5.2.4. The slings or other approved devices are seated properly in the saddle of the hook before operation.

7.2.4.5.3. When moving the load:

7.2.4.5.3.1. The appointed person directing the lift will ensure the load is well secured and properly balanced in the sling or lifting device before it is lifted more than a few inches.

7.2.4.5.3.2. Before starting to hoist, the following conditions will be noted:

7.2.4.5.3.2.1. Hoist rope or chain is not kinked or twisted.

7.2.4.5.3.2.2. Multiple part lines are not twisted around each other.

7.2.4.5.3.2.3. The hook is brought over the load in a way that prevents swinging.

7.2.4.5.3.2.4. If there is a slack rope condition, the rope is properly seated on the drum and in the sheaves before continuing the lift.

7.2.4.5.3.3. Tag lines will be used for all free swinging loads.

7.2.4.5.4. During hoisting, care will be taken that:

7.2.4.5.4.1. There is no sudden acceleration or deceleration of the moving load.

7.2.4.5.4.2. Load does not contact any obstructions.

7.2.4.5.4.3. Equipment is not used for side pulls except when specifically authorized by a designated person who has determined the suitability of the equipment is not thereby endangered and that various parts of the equipment will not be overstressed.

7.2.4.5.4.4. The operator does not hoist, lower, or travel while anyone is on the load or hook unless specifically recommended for such use by the manufacturer, approved by MAJCOM, DRU, or FOA, and so indicated on a permanent name plate attached to the hoist. (See paragraph **9.6.** and 29 CFR 1926.550, Cranes and Derricks.)

7.2.4.5.4.5. The operator does not carry loads over personnel.

7.2.4.5.4.6. The operator tests the brakes each time a load is handled by raising the load 2 inches above floor or ground level and applying the brakes.

7.2.4.5.4.7. The load is not lowered below the point where less than two full wraps of rope remain on the hoisting drum. **EXCEPTION:** One wrap may remain on the drum if a lower limit device is provided. (See ANSI/ASME Standard B30-2.)

7.2.4.5.4.8. When two or more pieces of equipment are used to lift a load, one qualified responsible person is in charge of the operation. The person in charge analyzes the operation and instructs all personnel involved in the proper positioning, rigging of the load, and the movements to be made.

7.2.4.5.4.9. The operator does not leave his or her position at the controls while the load is suspended.

7.2.4.5.4.10. When starting the equipment and when the load or hook approaches near personnel, a warning signal is given.

7.2.4.5.4.11. Appropriate clearance is maintained between any part of the crane and electrical power sources.

7.2.4.6. Signals and Instruction. Standard signals given to the operator will be according to **Figure 7.1.**. Voice communication equipment (telephone, radio, or equivalent) will be fully operational when used. Signals and instructions will be distinct at all times. Hand signals as illustrated in **Figure 7.1.** will be conspicuously posted on or immediately near all cranes.

7.2.4.7. Personal Protective Equipment:

7.2.4.7.1. Protective helmets (hard hats) will be worn if there is a potential for injury from falling objects or moving equipment.

7.2.4.7.2. Safety-toe shoes will be worn by all personnel involved in materials handling when there is a danger of injuries.

7.2.4.7.3. Protective safety goggles will be worn when eye injury hazards, such as work-generated dirt, dust, or other airborne particles are present.

7.2.4.7.4. Gloves will be worn by workers performing hooking, unhooking, loading, handling tag lines, or unloading operations, when there is a potential for injury from punctures and severe cuts, lacerations, and abrasions.

7.2.4.8. Miscellaneous Requirements:

7.2.4.8.1. Ladders and Footwalks:

7.2.4.8.1.1. The supervisor will ensure workers keep their hands free of encumbrance while they are using ladders.

7.2.4.8.1.2. Articles which are too large to be carried in pockets or belts will be lifted and lowered by hand line.

7.2.4.8.1.3. Footwalks will be kept free of loose tools, parts, or other tripping hazards.

7.2.4.8.2. Cabs:

7.2.4.8.2.1. Necessary clothing and personal belongings will be stored in a way that does not interfere with access or operation.

7.2.4.8.2.2. Tools will be stored in approved tool boxes. Wastes will be disposed of in appropriate containers. No loose articles will be left in or about the cab.

7.2.4.8.3. Fire Extinguishers. Supervisors will ensure that operators are familiar with the operation and care of fire extinguishers provided. (See paragraph **7.2.2.10.**)

7.2.5. Maintenance and Testing:

7.2.5.1. Preventive Maintenance:

7.2.5.1.1. A preventive maintenance program based upon the manufacturer's recommendation will be established. Dated and detailed records will be maintained by the using agency and readily available.

7.2.5.1.2. All replacement parts should be obtained from the original equipment manufacturer or a manufacturer-approved source.

7.2.5.2. Maintenance Procedures:

7.2.5.2.1. Before adjustments and repairs are started, the following precautions will be taken:

7.2.5.2.1.1. Movable equipment shall be moved to a location where it will cause the least interference with other moving equipment on the system and operations in the area.

7.2.5.2.1.2. All controllers will be placed at the "off" position.

7.2.5.2.1.3. If electrically powered, the main or emergency switch will be locked in an open (off) position except for tests.

7.2.5.2.1.4. A "Do Not Start" tag will be placed on the main switch.

7.2.5.2.1.5. Where other moving units are in operation on the same runways or monorail track, rail stops or other suitable means will be provided to prevent interference with the idle equipment.

7.2.5.2.1.6. Where temporary protective rail stops are not possible or practical, a signal person will be placed at a visual vantage point to observe the approach of an active unit and to warn the operator when the limit of safe distance from the idle unit has been reached.

7.2.5.2.2. Equipment that cannot be readily moved from its operating location can be inspected and maintained at the site, providing precautions are taken to ensure the safety of the inspection and maintenance personnel.

7.2.5.2.3. After adjustments and repairs have been made, the equipment will not be operated until all guards have been reinstalled, safety devices are reactivated, and tools and maintenance equipment are removed. "Do Not Start" tags and locks will be removed by the supervisor or the person who attached them.

7.2.5.3. Adjustments and Repairs:

7.2.5.3.1. The using agency will ensure that any unsafe conditions disclosed by inspection are corrected before operation of the crane or monorail system is resumed. Adjustments and repairs will be done only by designated personnel.

7.2.5.3.2. Adjustments will be made to ensure correct functioning of all components such as:

7.2.5.3.2.1. Control systems.

7.2.5.3.2.2. All operating mechanisms.

7.2.5.3.2.3. Limit switches.

7.2.5.3.2.4. Drive wheels, squaring shafts, couplings, roller chain drives, bumpers, and stops.

7.2.5.3.2.5. Interlocks, crossovers, track switches, track-openers.

7.2.5.3.2.6. Collector shoes or wheel limit switches, electrical control systems, pushbutton stations, or controllers.

7.2.5.3.2.7. Brakes, hoist mechanisms, hydraulic units, hydraulic or pneumatic valves, and controls.

7.2.5.3.2.8. Power source.

7.2.5.3.3. Repairs or replacements will be provided promptly as needed for safe operation. The following are examples:

7.2.5.3.3.1. Hoist mechanisms showing defects as described in **Chapter 5**.

7.2.5.3.3.2. Hooks showing damage as described in **Chapter 9**.

7.2.5.3.3.3. Damage to components listed in paragraph **7.2.5.3.2.**, which have been determined to constitute a safety hazard.

7.2.5.3.3.4. Load attachment chains and rope slings showing defects.

7.2.5.3.3.5. All critical parts which are cracked, broken, bent, or excessively worn.

7.2.5.3.3.6. Dirty pendant control stations and illegible function labels.

7.2.5.4. Rope Maintenance. Refer to **Chapter 9**

7.2.5.5. Rope Replacement. Refer to **Chapter 9**

7.2.5.6. Testing:

7.2.5.6.1. Operational Tests:

7.2.5.6.1.1. Prior to initial use, all new and altered equipment or equipment which has not been used within the preceding 12 months will be tested for compliance with this standard, including functions such as the following:

7.2.5.6.1.1.1. Hoisting and lowering.

7.2.5.6.1.1.2. Trolley travel.

7.2.5.6.1.1.3. Bridge travel.

7.2.5.6.1.1.4. Travel limiting devices.

7.2.5.6.1.1.5. Locking and safety devices for interlocking mechanism, track switches, drop sections, and lift sections.

7.2.5.6.1.2. The trip setting of hoist limit switches will be determined by tests with an empty hook traveling in increasing speeds up to the maximum speed. The actuating mechanism of the limit switch will be located so it will trip the switch under all conditions, in sufficient time to prevent contact of the hook or load block with any part of the trolley.

7.2.5.6.1.3. Ensure the following rules are obeyed on hoist limit switch:

7.2.5.6.1.3.1. At the beginning of each operator shift, during each periodic maintenance, and at any time a malfunction is suspected or after unusually heavy use, the operator or maintainer will check the upper-limit switch under no load. Care will be exercised: the block will be "inched" into the limit switch or run in at slow speed. If the switch does not operate properly, the operator will immediately notify the operation supervisor.

7.2.5.6.1.3.2. The hoist limit switch which controls the upper limit of travel of the load block will never be used as an operating control.

7.2.5.6.2. Load Test:

7.2.5.6.2.1. All new hoists will have the manufacturer’s certification that all proof load testing has been accomplished. Prior to initial use, all extensively repaired and altered equipment will be tested by or under the direction of a designated person and a written report furnished by such person, confirming the load rating of the system. Test loads will not be more than 125 percent of the rated load unless otherwise recommended by the manufacturer. These test reports will be maintained by the user and will be readily available.

7.2.5.6.2.2. On hoists incorporating overload devices which prevent the lifting of 125 percent rated load, a load test will be accomplished with at least 100 percent of rated load, after which the function of the overload device will be tested. Nuclear certified hoists

require annual proof-load testing at 125 percent. Overload devices that prevent this testing will not be used.

7.2.5.6.2.3. Test weights utilized for load testing shall be tagged or marked indicating total weight in pounds and owner and (or) agency identification number. Rebar steel shall not be used for test weight lift points.

7.2.5.7. Inspection:

7.2.5.7.1. Frequent. Visual inspections by the operator or designated person daily or prior to each use with no record of the inspection required. The following items shall be inspected:

7.2.5.7.1.1. Operating mechanisms for proper operation, proper adjustment, and unusual sounds;

7.2.5.7.1.2. Upper limit devices;

7.2.5.7.1.3. Tanks, valves, pumps, lines, and other parts of air or hydraulic systems for leakage;

7.2.5.7.1.4. Hooks and hook safety latches, according to paragraphs **5.2.5.1.** and **9.4.**

7.2.5.7.1.5. Hoists, according to **Chapter 5**

7.2.5.7.2. Periodic. Complete inspections of the crane shall be performed at intervals between 1 and 12 months by a designated person who makes records of the inspection. The recommended intervals for these inspections should be based upon the type of use experienced by the equipment as follows: Normal use -- yearly; heavy use -- semiannually; and severe use -- quarterly. ***Note: For nuclear certified monorail systems, the periodic inspection shall be performed semi-annually by civil engineering or equivalent. These inspections will include the requirements in paragraph 7.2.5.7.1. and in addition, items such as the following:***

7.2.5.7.2.1. Deformed, cracked, or corroded members;

7.2.5.7.2.2. Loose belts or rivets;

7.2.5.7.2.3. Cracked or worn sheaves and drums;

7.2.5.7.2.4. Worn, cracked, or distorted parts, such as pins, bearings, wheels, shafts, gears, rollers, locking and clamping devices, bumpers, switch baffles, interlock bolts, and trolley stops;

7.2.5.7.2.5. Excessive wear on brake system parts;

7.2.5.7.2.6. Signs of any deterioration of electrical apparatus, including, but not limited to, controllers, master switches, contacts limit switches and push-button stations;

7.2.5.7.2.7. Worn drive wheels and (or) tires; and

7.2.5.7.2.8. Periodic inspection of overhead hoists according to **Chapter 5** ***NOTE:*** For suspended powered monorail systems, inspect the following in addition to the requirements above:

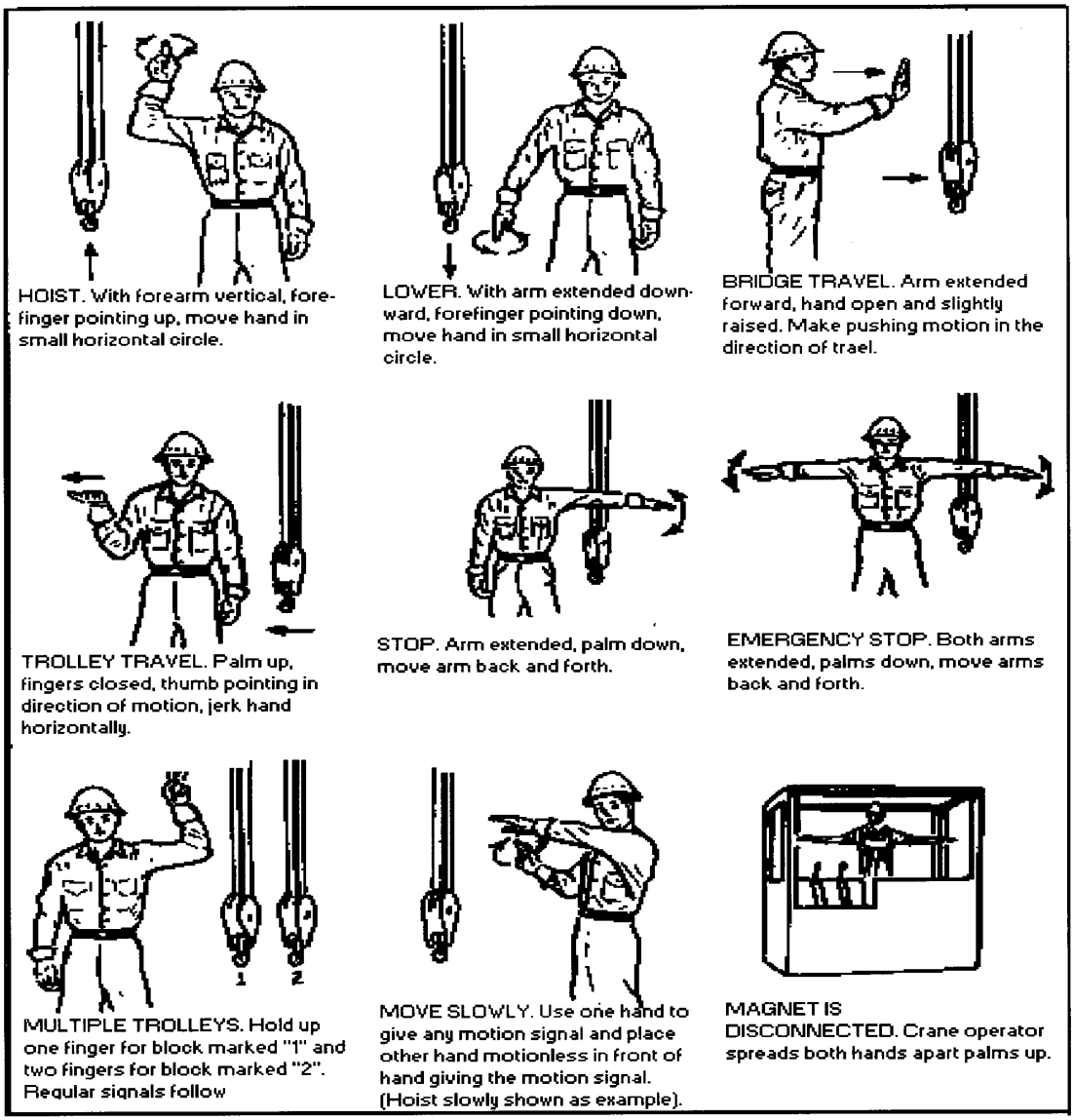
7.2.5.7.2.8.1. Power rails for misalignment at all splices, switches, and rail-end joints.

7.2.5.7.2.8.2. All rail hangers for security.

7.2.5.7.2.8.3. Idlers at switches, clean paths, and lubricate as necessary.

7.2.5.7.2.8.4. Switches throughout rail travel for alignment.

Figure 7.1. Hand Signals for Controlling Overhead and (or) Gantry Crane Operations.



Chapter 8

MOBILE AND LOCOMOTIVE CRANES

8.1. Hazards and (or) Human Factors:

8.1.1. One of the greatest hazards associated with mobile crane operations is electrocution resulting from the equipment coming in contact with energized electric lines.

8.1.2. Other potential hazards to personnel and property are: overloading, sideloading, rope or hydraulic failure; striking people or objects with moving loads or movable parts of the crane; dropping or slipping of the load due to improper hitching or slinging; failure to use outriggers, floats, blocks, or mats; operating on a surface that is not stable or level; slipping or falling from equipment; failure to use available safety devices such as brakes, locks, and warning signals; failure to detect or correct equipment deficiencies or malfunctions; ignoring inspection and maintenance requirements; misuse of the machine; and unqualified personnel operating the equipment.

8.1.3. Where feasible, safeguards have been built-in to minimize the probability for human error, but hazards that cannot be abated by mechanical means still exist. It is important that supervisors select individuals who are physically and mentally fit to operate cranes. Poor coordination or mental alertness, visual acuity, depth perception, peripheral vision, color vision, and reaction time can be contributing factors to mishaps. (Refer to paragraph **8.2.4.1.2.** for operator physical qualifications.)

8.2. Requirements:

8.2.1. Acquisition:

8.2.1.1. All crawler, locomotive, and truck cranes will meet the design specifications, characteristics, and rules of ANSI/ASME B30.5, Mobile and Locomotive Cranes.

8.2.1.2. All new mobile hydraulic cranes constructed and used on or after 25 January 1982 will meet the safety code requirements of ANSI/ASME B30.5. Equipment manufactured prior to the effective dates of the referenced ANSI Standard and still in replacement codes A through J as of the date of this AFOSH Standard need not be modified or retrofitted to conform to this standard. Following are general design considerations which shall be included in procurement documents:

8.2.1.2.1. Load Ratings and Charts. A substantial and durable rating chart with clearly legible letters and figures will be provided with each crane and securely fixed to the crane cab in a location easily visible to the operator while seated at the control station. A duplicate load rating chart (legible from the ground) should also be provided on the outside of the crane. The load rating chart for truck cranes may list loads for the crane operating both with and without counterweights.

8.2.1.2.2. Two-Blocking Prevention. On telescoping boom cranes, a two-blocking damage preventive feature shall be provided. It shall be capable of preventing damage to the hoist rope or other machine components when hoisting the load, extending the boom, or lowering the boom on a machine having a stationary hoist mounted to the rear of the boom hinge.

8.2.1.2.3. Boom Angle Indicator. A boom angle indicator shall be provided on all cranes.

8.2.1.2.4. Overload Protection. Devices such as "Load Moment Indicators" are commercially available and are designed to alarm the operator and (or) de-energize the crane when attempt-

ing to lift a load that is beyond the capabilities of the crane. Although these devices would be of minimal value in routine base-level Air Force operations, they may be of some value in operations involving construction where load may not be defined or identified or when a load has not been properly released from its transporter. The user must evaluate the current and anticipated use of the crane to determine the need for such a device.

8.2.1.2.5. Color Coding for Strike Hazard. Those portions of crane cabs that extend beyond the main chassis when rotated will be color coded yellow and black on the lower areas to denote a strike hazard to personnel on the ground. Colors will be reflective for night operations.

8.2.1.2.6. Guarding of Machinery. Exposed moving parts such as gears, set screws, projecting keys, chains, chain sprockets, and reciprocating parts (which might constitute a hazard to operating personnel under normal operating conditions) will be guarded.

8.2.1.2.7. Unguarded Machinery Conditions. Crane operations have inherent hazards, such as rotating equipment and (or) holes, etc., that cannot be mechanically safeguarded against. To prevent severe injury to personnel, they will exercise extreme care when they are exposed to unguarded and (or) rotating equipment and (or) holes. Such conditions will be clearly marked with appropriate warning decals.

8.2.1.2.8. Main Switch. If the mobile crane is electrically powered separately and incorporates a main or master switch, the switch will be designed so it can be locked in the open or "OFF" position.

8.2.1.2.9. Operator Protection. Cranes will be fitted with adequate equipment to protect operators from falling objects, swinging loads, and cable failures. Where cranes are operated in inclement weather, protection from the weather will also be provided.

8.2.1.2.10. Warning. An efficient audible warning device will be provided when hoisting operations or moving equipment might endanger personnel working in the area. The control of the device will be within easy reach of the operator.

8.2.1.2.11. Warning Sign. A permanent sign will be posted in the cab of the equipment in full view of the operator. This sign will read: "DANGER HIGH VOLTAGE, Do Not Operate Within 10 Feet of Electric Power Lines." If equipment will be expected to be operated in the vicinity of power lines, the installation of a proximity device should be considered.

8.2.1.2.12. Night Operations. Cranes operated during darkness will have clearance lights installed. The working areas will be illuminated so the designated signal person, loads, rigging, obstructions, etc., are readily visible.

8.2.1.2.13. Man-Rated Cranes. Man-rated cranes will be approved, prior to acquisition or use. The potential user will coordinate with the safety staff and submit the following for review (see 29 CFR 1926.550 for additional information):

8.2.1.2.13.1. Crane make, model, year, and present modifications if applicable.

8.2.1.2.13.2. Present safety devices, limit switches, dead-man controls, control lowering capabilities, outriggers if applicable, etc.

8.2.1.2.13.3. Past major overhaul or repairs and dates of proof load or rated load test.

8.2.1.2.13.4. Proposed method of use and working environment.

8.2.1.2.13.5. Proposed work cage and (or) basket, attachment points, and methods of attachment for personnel.

8.2.1.2.13.6. If necessary, illustrated drawings or photographs.

8.2.2. Inspections:

8.2.2.1. New or Modified Cranes. All newly procured or modified cranes will be inspected prior to initial use, to ensure compliance with this standard.

8.2.2.2. Daily Inspections. Every working day, the following will be inspected by the operator:

8.2.2.2.1. Hydraulic Hose, Fittings, and Tubing. All hydraulic hoses, particularly those which flex in normal operation of crane functions, will be visually inspected. Any deterioration should be examined and determination made whether further use of the component would constitute a safety hazard. Conditions such as the following should be sufficient reason for consideration of replacement:

8.2.2.2.1.1. Any evidence of hydraulic oil leakage at the surface of the flexible hose or any excessive leakage at its junction with the metal end couplings.

8.2.2.2.1.2. Any blistering or abnormal deformation to the outer covering of the hydraulic hose.

8.2.2.2.1.3. Hydraulic oil leakage at any threaded or clamped joint that cannot be eliminated by normal tightening or recommended procedures.

8.2.2.2.1.4. Evidence of excessive abrasion or scrubbing on the outer surface of a hose, rigid tube, or hydraulic fitting. Action will be taken immediately to eliminate or correct the cause or otherwise protect the components from additional damage.

8.2.2.2.2. Pumps and Motors. The following may be reason for replacement or repair:

8.2.2.2.2.1. Loose bolts or fasteners.

8.2.2.2.2.2. Leaks at joints between sections.

8.2.2.2.2.3. Shaft seal leaks.

8.2.2.2.2.4. Unusual noises or vibration.

8.2.2.2.2.5. Loss of operating speed.

8.2.2.2.2.6. Suspected overheating of the hydraulic oil.

8.2.2.2.2.7. Inability to hold proper pressure.

8.2.2.2.3. Valves. The following may be reason for replacement or repair:

8.2.2.2.3.1. Cracks in valve housing.

8.2.2.2.3.2. Improper return of spool to neutral position.

8.2.2.2.3.3. Leaks at spools or joints.

8.2.2.2.3.4. Sticking spools.

8.2.2.2.3.5. Failure of relief valves to attain correct pressure setting as specified by the manufacturer.

8.2.2.2.4. Cylinders. The following may be reasons for replacement or repair:

8.2.2.2.4.1. Drifting caused by oil leaking across piston.

8.2.2.2.4.2. Rod seals leaking.

8.2.2.2.4.3. Leaks at welded joints.

8.2.2.2.4.4. Scored, nicked, or dented cylinder rods.

8.2.2.2.4.5. Dented case (barrel).

8.2.2.2.4.6. Loose or deformed rod eyes or connecting joints.

8.2.2.2.5. Filters. Evidence of rubber particles on the filter element may indicate hose, "O" ring, or other rubber component deterioration. Metal chips or pieces on the filter may denote failure in pumps, motors, or cylinders. Further checking will be necessary to determine origin of the problem before corrective action can be taken.

8.2.2.2.6. Control Mechanisms. These mechanisms will be checked for maladjustment.

8.2.2.3. Monthly Inspections. The following items will be inspected by the operator or designated person for defects at intervals (at least monthly) specified by the Vehicle Maintenance Officer. The inspection will include observation during the crane's operation.

8.2.2.3.1. Vehicle control mechanisms for excessive wear of components and contamination by lubricants or other foreign matter.

8.2.2.3.2. Installed safety devices for proper operation.

8.2.2.3.3. Crane hooks for deformations or cracks; or having more than 15 percent in excess of normal throat opening or more than 10 degrees twist from the plane of the unbent hook refer to paragraph **8.2.3.3.4.**).

8.2.2.3.4. Rope reeving for compliance with crane manufacturer's recommendation.

8.2.2.3.5. Electrical apparatus for malfunctions, signs of excessive deterioration, or dirt and moisture accumulation.

8.2.2.3.6. Hydraulic hoses, fittings, and tubing for deterioration (refer to paragraph **8.2.2.2.1.**).

8.2.2.4. Annual Inspections. The Vehicle Maintenance Officer is responsible to ensure that complete inspections of the crane will be performed at intervals (at least annually) or as directed or recommended by the manufacturer. These inspections will be performed by a qualified person and will include the requirements of paragraphs **8.2.2.2.** and **8.2.2.3.** and the following items:

8.2.2.4.1. Deformed, cracked, or corroded members in the crane structure and boom.

8.2.2.4.2. Loose bolts or rivets.

8.2.2.4.3. Cracked or worn sheaves and drums.

8.2.2.4.4. Worn, cracked, or distorted parts such as pins, bearings, shafts, gears, rollers, and locking devices.

8.2.2.4.5. Excessive wear on brake and clutch system parts, linings, pawls, and ratchets.

8.2.2.4.6. Any inaccuracies of load and check boom angle indicators and other indicators over their full range.

8.2.2.4.7. Proper performance of gasoline, diesel, electric, or other power plants.

8.2.2.4.8. Excessive wear of chain-drive sprockets and excessive chain stretch.

8.2.2.4.9. Cracks in crane hooks by magnetic particle or other suitable crack detecting inspection.

8.2.2.4.10. Proper operation of travel steering, braking, and locking devices.

8.2.2.4.11. Worn or damaged tires.

8.2.2.4.12. Rust on hydraulic rods and control valves.

8.2.2.4.13. Cleanliness of oil filters and oil strainers.

8.2.2.4.14. For nuclear certified mobile hydraulic cranes, complete a load test per the NOTE in paragraph **8.2.3.1.1.**

8.2.2.5. Cranes Not in Regular Use:

8.2.2.5.1. A crane which has been idle for a period of 1 month or more, but less than 6 months, will be given an inspection conforming with requirements of paragraph and **Chapter 9**.

8.2.2.5.2. A crane which has been idle for a period of over 6 months will be given a complete inspection conforming with requirements of paragraphs **8.2.2.2.** and **8.2.2.3.** and **Chapter 9** before being placed in service.

8.2.2.5.3. Standby cranes will be inspected at least semiannually according to the requirements of paragraphs **8.2.2.2.** and **8.2.2.3.** and **Chapter 9**. The need for more frequent inspections of cranes exposed to an adverse environment should be determined by the user.

8.2.2.6. Inspection Records. Inspection records will be maintained according to AFI 24-302 (formerly designated AFM 77-310, Volume 2), Vehicle Maintenance Management, or other appropriate directives and their location will be determined by the user.

8.2.3. Maintenance and Testing:

8.2.3.1. Load Test:

8.2.3.1.1. Prior to initial use, extensively repaired or modified cranes will be load tested to 110 percent of rated capacity by the owning activity. Upon completion of the test, the weight load test date will be stenciled on the lower boom assembly as per TO 00-20B-5, USAF Motor Vehicle and Vehicle Equipment Inspection. A new crane will have the manufacturer's certification that all load testing has been accomplished. **NOTE:** For nuclear certified hydraulic mobile cranes, perform an annual load test of 100 percent of the rated capacity.

8.2.3.1.2. Test loads will not exceed 110 percent of the rated load at any selected working radius.

8.2.3.1.3. If it is determined that rerating is necessary, crawler, truck and wheel-mounted mobile cranes will be tested according to Society of Automotive Engineers, Inc. (SAE) Recommended Practices, Crane Load Stability Test Code J765. Locomotive cranes will be rerated

according to manufacturers' specifications. A copy of the rerating test report will be provided to Vehicle Maintenance Control and a copy posted in the cab of the crane.

8.2.3.1.4. Cranes will not be rerated in excess of the original load ratings unless such rating changes are approved by the crane manufacturer.

8.2.3.1.5. A record of all tests will be maintained by the owning and (or) using agency.

8.2.3.1.6. Test weights utilized for load testing shall be tagged or adequately marked indicating total weight in pounds and owner and (or) agency identification number. Rebar steel shall not be used for test weight lift points.

8.2.3.2. Maintenance Procedure. A preventive maintenance program based on this standard and crane manufacturers' recommendations will be established by the Vehicle Maintenance Officer. Records of maintenance on the crane will be maintained according to AFI 24-302 or other appropriate directives.

8.2.3.2.1. Before adjustments and repairs are started on a crane the following precautions will be taken as applicable:

8.2.3.2.1.1. Locate the crane where it will cause the least interference with other equipment or operations.

8.2.3.2.1.2. Place warning "Do Not Start" tag on the crane energy control.

8.2.3.2.1.3. Lower the boom to the ground if possible or secure it against dropping.

8.2.3.2.1.4. Lower the lower load block to ground or secure it against dropping.

8.2.3.2.1.5. Stop the power plant.

8.2.3.2.1.6. Disengage and lockout all starting controls.

8.2.3.2.1.7. Turn off all controls and engage the pawls.

8.2.3.2.1.8. Relieve hydraulic oil pressure from all hydraulic systems before loosening or removing hydraulic components.

8.2.3.2.1.9. Retract all hydraulic cylinders used for boom hoisting and boom telescoping.

8.2.3.2.2. After adjustments and repairs have been made, the crane will not be operated until all guards have been reinstalled, trapped air removed from hydraulic system, safety devices reactivated, and maintenance equipment removed.

8.2.3.2.3. Warning tags and (or) locks will only be placed or removed by the maintenance supervisor or his or her representative.

8.2.3.3. Adjustments and Repairs:

8.2.3.3.1. Any unsafe conditions, disclosed by the inspection requirements of paragraph **8.2.2.** will be corrected before the crane is operated again. Adjustments and repairs will be done only by designated personnel.

8.2.3.3.2. Adjustments to all functional operating mechanisms, safety devices, control systems, and power plants will be maintained to ensure correct functioning of components.

8.2.3.3.3. All critical parts of functional operating mechanisms or crane structures which are cracked, broken, bent, corroded, or excessively worn will be repaired or promptly replaced to ensure safe operation.

8.2.3.3.4. Crane hooks showing defects described in paragraph **8.2.2.3.3.**. will be discarded. Field repairs by welding or reshaping will not be permitted. **EXCEPTION:** See ANSI B30.10.

8.2.3.3.5. All replacement parts or repairs will have at least the original manufacturer's design safety factor.

8.2.3.4. Lubrication:

8.2.3.4.1. All moving parts of the crane, for which lubrication is specified, will be regularly lubricated. Care should be taken to follow manufacturer's recommendations or TO procedures as to points and frequency of lubrication, maintenance of lubricant levels, and types of lubricant to be used.

8.2.3.4.2. Unless the crane is equipped for automatic or remote lubrication, it will be stationary while being lubricated and all controls will be at the "OFF" position, the main power control switch, if equipped, locked out or "off," and pawls applied.

8.2.4. Qualification of Operators:

8.2.4.1. Crawler, Locomotive, Truck, and Mobile Hydraulic Cranes:

8.2.4.1.1. The examinee for an AF Form 483, **Certificate of Competency,** will pass a written examination containing the safety requirements of this chapter and TO 36C-1-5, 60 Rules on Safety. The examinee will also be given a practical operating examination (which will be developed by the using activity) to demonstrate task-qualification to operate the crane safely.

8.2.4.1.2. Operators shall meet the following minimum physical qualifications:

8.2.4.1.2.1. Have vision of at least 20/30 Snellen in one eye, and 20/50 in the other, with or without glasses.

8.2.4.1.2.2. Be able to distinguish red, green, and yellow, regardless of position of colors.

8.2.4.1.2.3. Test for ordinary conversation in one ear, with or without a hearing aid, to ensure there is adequate hearing for a specific operation.

8.2.4.1.2.4. Have sufficient strength, endurance, agility, coordination, and speed of reaction to meet the demands of equipment operation.

8.2.4.1.2.5. Evidence of physical defect, or emotional instability which could render the operator a hazard to himself or others, or which in the opinion of the examiner or supervisor could interfere with the operator's safe performance, may be sufficient cause for disqualification. In such cases specialized clinical or medical judgments and tests may be required. ***Note: A history of epilepsy or a disabling heart condition may be sufficient reason for disqualification.***

8.2.4.1.3. Potential operator trainees will have good depth perception, field of vision, reaction time, manual dexterity or coordination, and no tendencies to dizziness or similar undesirable characteristics. Physical defects such as loss of arm, hand, leg, foot, or gross loss of function

thereof may be considered as cause for denial of acceptance into an entry level training program for operators.

8.2.5. Use. Mobile cranes will be operated only by authorized, qualified operators who possess a valid AF Form 483 or by persons in training under the direct supervision of a designated operator. The only other personnel who will enter a crane cab are persons such as oilers, supervisors, and inspectors whose duties require them to do so. A list of qualified crane operators will be kept by the using organization and appropriate entries will be made in the individual's training records.

8.2.6. Operating Practices:

8.2.6.1. If the operator must divert their attention elsewhere while operating the crane they will stop the crane.

8.2.6.2. The operator will respond to signals only from the designated signal person, but will obey an emergency stop signal at any time no matter who gives it.

8.2.6.3. The operator will be responsible for those operations under their direct control. Whenever there is any doubt as to safety, the operator will have the authority to stop and refuse to handle loads until safety has been ensured.

8.2.6.4. The operator will sound or give an audible warning signal each time before traveling (backing), and when approaching workmen or other congested areas. The signal may be mechanical (automatic) or oral.

8.2.6.5. Before leaving their crane unattended, the operator will:

8.2.6.5.1. Lower to the ground any suspended load, bucket, lifting magnet, or other device.

8.2.6.5.2. Disengage clutch.

8.2.6.5.3. Set travel, swing, boom brakes, and other locking devices.

8.2.6.5.4. Put controls in the "OFF" or neutral position.

8.2.6.5.5. Stop the engine.

8.2.6.5.6. Secure crane, i.e., chocks, brakes, etc., against accidental travel.

8.2.6.6. During periods of non-use, high winds, or weather alerts, the operator will lower the boom to ground level or to a resting platform or otherwise ensure the boom is secure against displacement from wind loads or other outside forces.

8.2.6.7. If there is a warning tag or lock on the switch or engine starting controls, the operator will not close the switch or start the engine until the warning tag or lock has been removed by the supervisor or the person who originally attached the device.

8.2.6.8. Before closing the switch or starting the engine, the operator will ensure all controls are in the "OFF" position and all personnel are clear of the crane.

8.2.6.9. If power fails during operation, the operator will:

8.2.6.9.1. If practical, lower to the ground the suspended load under brake control. If not practical to land the load, shut down the crane and completely rope off and (or) barricade the area around the suspended load.

8.2.6.9.2. Set all brakes and locking devices.

8.2.6.9.3. Move all clutch or other power controls to the "OFF" position.

8.2.6.10. The operator will be familiar with the equipment and its proper care. If adjustments or repairs are necessary or any damage is known, they will report them promptly to the supervisor and will record them on Air Force Technical Order (AFTO) Form 89, ***Daily Inspection Worksheet for Locomotive Cranes Other Than Steam,*** or other appropriate inspection and maintenance forms.

8.2.6.11. All controls will be tested by the operator at the start of a new shift. If any controls do not operate properly, they will be adjusted or repaired before continuing operation.

8.2.6.12. Booms which are being assembled or disassembled on the ground, with or without support of the boom harness, should be securely blocked to prevent dropping of the boom and boom sections.

8.2.6.13. Booms which are being manually telescoped should be carefully repositioned prior to pinning, to prevent injury to personnel.

8.2.6.14. No crane will be loaded beyond its rated load, except for test purposes as provided in paragraph **8.1.3.** The weight of all loads will be determined before lifting.

8.2.6.15. When attaching the load, the hoist rope will not be wrapped around the load. The load will be attached to the hook by means of slings or other approved devices of proper capacity.

8.2.6.16. When moving the load the supervisor directing the lift will ensure:

8.2.6.16.1. The crane is level and, where necessary, blocked properly. Outriggers will be used. (See paragraph **8.2.6.24.**)

8.2.6.16.2. The load is well secured and properly balanced in the sling or lifting device before it is hoisted more than a few inches.

8.2.6.17. Before starting to hoist, the operator will ensure that:

8.2.6.17.1. The hoist rope is not kinked;

8.2.6.17.2. Multiple part lines are not twisted around each other;

8.2.6.17.3. The hook is brought over the load in a manner to prevent swinging; and

8.2.6.17.4. If there is a slack rope condition, the rope is properly seated on the drum and in the sheaves as the load is applied.

8.2.6.18. During hoisting the operator will ensure that:

8.2.6.18.1. There is no sudden acceleration or deceleration of the moving load; and

8.2.6.18.2. Load and boom do not contact any obstructions.

8.2.6.19. Side loading of booms will be limited to freely suspended loads. Cranes will not be used for dragging loads sideways.

8.2.6.20. The crane will not be operated while anyone is on the load or hook. MAJCOM, DRU, or FOA approved man-rated cranes and work cages are permitted (see paragraph **8.2.6.50.** for hoisting and [or] lowering personnel).

8.2.6.21. The operator will not carry or swing a load over the heads of personnel.

8.2.6.22. On truck mounted cranes, loads will not be lifted over the front area of the truck unless specifically allowed in the manufacturer's operating instructions.

8.2.6.23. The operator will test the brakes each time a load is handled, by raising the load a few inches and applying the brakes.

8.2.6.24. Outriggers will be used. When floats are used they will be securely attached to the outriggers. Blocking used to support outriggers will be strong enough to prevent crushing, not have defects, and be wide enough and long enough to prevent shifting or toppling of the crane under load.

8.2.6.25. Neither the load nor the boom will be lowered beyond the point where less than two full wraps of rope remain on their respective drums.

8.2.6.26. When two or more cranes are used to lift one load, one designated person will be responsible for the operation. They will analyze the operation and instruct all personnel involved in the proper positioning, rigging of the load, and the movements to be made.

8.2.6.27. Before any crane is moved to a new job site, the route of travel will be checked to determine that adequate clearances exist along the entire route. This survey will be conducted by the vehicle heavy equipment supervisor and crane operator. The empty hook will be secured to prohibit swinging and the boom will be lowered to the boom rest or travel position. A red cloth or warning flag, at least 12 inches square, or a warning light will be carried at the end of any boom that extends more than 4 feet beyond the truck platform. At night a warning light shall be used. The superstructure will be secured to prohibit rotation except when there is an operator in the cab to ensure proper boom clearances around tight spots and corners. Additional vehicles will be used to aid in warning other motorists if the crane boom or wide load poses a hazard to the front or rear.

8.2.6.28. Before traveling a crane with a load, a designated supervisor will be responsible for determining and controlling safety. Decisions such as position of load, boom location, ground support, travel route, and speed of movement will be according to their determination. Specified tire pressures will be maintained. The boom will be carried in line with the direction of motion, sudden starts and stops will be avoided, and tag or restraint lines will be used to minimize swinging of the load.

8.2.6.29. A crane will never travel with the boom so high that it may bounce back over the cab. The manufacturer's operation manual will be consulted.

8.2.6.30. When rotating the crane, sudden starts and stops will be avoided. Rotational speed will be such that the load can be controlled. A tag line will be used when rotation of the load is hazardous.

8.2.6.31. When a crane is to be operated at a fixed radius, the boom hoist pawl or other positive locking device will be engaged on rope supported booms.

8.2.6.32. Ropes will not be handled on a winch head without the knowledge of the operator. While a winch head is being used, the operator will be within convenient reach of the power unit control lever.

8.2.6.33. On cranes having a powered telescoping boom, the hook is drawn closer to the boom head when hoisting, extending the boom, or lowering a boom on machines where the winch is mounted stationary to the rear of the boom hinge. If the machine is not equipped with a

"two-blocking damage preventive feature," rope will be "let-out" from the load hoist mechanism so the hook will not be jammed (two-blocked) against the boom head. The jammed condition may cause overload and result in rope or other component failure.

8.2.6.34. Telescoping boom sections will be telescoped in the manner and sequence specified by the manufacturer.

8.2.6.35. While holding the load:

8.2.6.35.1. The operator will not leave his or her position at the controls when the load is suspended.

8.2.6.35.2. No person will be permitted to stand or pass under a suspended load.

8.2.6.35.3. If the load hoist mechanism is not equipped with a means to hold the drum from rotating in the lowering direction, without further action by the operator, loads should not remain suspended for a considerable length of time.

8.2.6.36. Standard hand signals to the operator will be according to those depicted in **Figure 7.1.** unless voice communication equipment is used. The operator will not respond to any signal unless he or she clearly understands it.

8.2.6.37. If it is necessary to give instructions to the operator other than those provided herein, the crane motions will be stopped.

8.2.6.38. All crane controls will be placed in the "OFF" position and the main switch opened when equipment is not being used.

8.2.6.39. When operating near electric power lines (29 CFR 1926.550):

8.2.6.39.1. Overhead power lines will be considered to be energized unless it is definitely known by the operator and supervisor that the lines are not energized.

8.2.6.39.2. No part of a crane or its load will be permitted to come within 10 feet of any energized electrical power line. When this is impractical, the electrical power line will be de-energized and visibly grounded, or a different route of travel will be used.

8.2.6.39.3. For lines rated over 50 kilovolts (kV), minimum clearance will be 10 feet plus 0.4 inch for each kV over 50 kV, or twice the length of the line insulator but never less than 10 feet.

8.2.6.39.4. A permanent sign will be posted in the cab of the equipment in full view of the operator. This sign will read: "DANGER -- HIGH VOLTAGE, Do Not Operate Within 10 Feet of Electric Power Lines."

8.2.6.39.5. A dielectric boom shield and insulated link installed in the lifting line at the hook will provide some protection against electric shock if the crane accidentally comes in contact with energized electric lines. Proximity warning devices are not fail safe and should be used in addition to, but not as a replacement for, other controls. Even though shields, insulated hooks, and proximity warning devices are used, the clearance criteria specified in paragraphs **8.2.6.39.2.** and **8.2.6.39.3.** shall be followed.

8.2.6.39.6. If the boom of a rubber-tired crane contacts an electric power line, it is probable that the entire piece of equipment will be energized since the rubber tires may insulate the crane from the ground. When this happens, operators will not attempt to leave the crane until

they are certain that either the line is clear of the crane or the line is de-energized. To make such an attempt might result in electrocution since the operator's body would complete the circuit to ground as he or she climbed or stepped from the crane. If the fuel tank should become ignited, or if for any other reason it is impossible for the operator to remain on the crane, they should jump, after first making sure that all parts of their body are clear of the crane before their feet touch the ground.

8.2.6.40. Except as otherwise stated herein, operators of mobile cranes will maintain at least 2 feet of clearance from all walls, overhead trestles, columns and other structures. In operations where motorized and (or) pedestrian traffic is anticipated or encountered, the working area will be blocked off or controlled to keep people and vehicles away.

8.2.6.41. Appropriate head protection will be worn by crane crew personnel when such protection is needed to protect workers from falling objects or impact type hazards. Safety-toe shoes will be worn by all materials handling and construction personnel involved in crane operations.

8.2.6.42. Rail clamps will not be used as means of restraining tipping of a locomotive crane. The weight of loads will be kept within the limitations of the cranes without using these clamps.

8.2.6.43. Cranes will not be operated without the full amount of ballast or counterweight in place, unless specifically authorized by the manufacturer's instructions.

8.2.6.44. Clothing and personal belongings will be kept away from operator controls. Tools, oil cans, waste, extra fuses and other necessary articles will be stored in the tool box and will not be permitted to lie loose in or about the cab.

8.2.6.45. Firm, level (within 1 percent) footing under the crane is essential to prevent it from tipping or sinking as loads are lifted and swung. Where necessary, this footing will be provided by timbers, cribbing, or other structural material sufficient to distribute the load and provide a level surface. Outriggers (on cranes so equipped) will be fully extended per manufacturer's specifications.

8.2.6.46. When small, portable containers are used to refuel engines, they will be approved safety containers with an automatic closing cap and flame arrester. The crane will not be refueled when the engine is running or hot.

8.2.6.47. A fire extinguisher rated for Class B and C fires will be provided at the operator's station. Operating and maintenance personnel will be familiar with the care and use of the extinguisher provided.

8.2.6.48. Operation of locomotive cranes will cease when railway cars on adjacent tracks are in motion.

8.2.6.49. All hooks and hook blocks shall be permanently marked with the manufacturer's identification. Load hooks shall be equipped with safety latches.

8.2.6.50. The use of a crane or derrick to hoist workers on a personnel platform is prohibited except when conventional means of reaching the worksite, such as personnel hoist, ladder, stairway, aerial lift, elevating work platform or scaffold, would be more hazardous or is not possible. (See paragraph **9.6.**.)

8.2.6.51. The area in the rear (in which someone could be struck or caught by the rotating super structure) shall be barricaded. (29 CFR 1926.550)

8.2.6.52. **Chapter 9** will be referred to for information on wire rope inspection, replacement, and maintenance.

Chapter 9

RELATED HOISTING EQUIPMENT

9.1. Wire Ropes:

9.1.1. Use and Attachment Considerations:

9.1.1.1. The crane manufacturer's recommendation will be followed when hoisting ropes are used.

9.1.1.2. Socketing will be done in the manner specified by the manufacturer of the assembly.

9.1.1.3. Swaged or compressed fittings will be applied as recommended by the rope or crane manufacturer.

9.1.1.4. Rope will be secured to the drum as follows:

9.1.1.4.1. No less than two wraps of rope will remain on the drum when the hook is in its extreme lowest position.

9.1.1.4.2. The rope end will be anchored by a clamp securely attached to the drum or by a socket arrangement approved by the crane or rope manufacturer.

9.1.1.4.3. If the crane is dual-reeved with the rope terminated at the equalizer, the termination fitting shall be rated as developing 100 percent of the rope strength.

9.1.1.5. Rope clips attached with U-bolts will have the U-bolts on the dead or short end of the rope. Spacing and number of all types of clips shall be according to the clip manufacturer's recommendation or **Figure 9.1.**. Clips shall be drop-forged steel in all sizes manufactured commercially. When a newly installed rope has been in operation for an hour, all nuts on the clip bolts shall be retightened. (Refer to **Figure 9.1.** through **Figure 9.4.** and **Table 9.1.**)

9.1.2. Maintenance:

9.1.2.1. Rope will be stored and handled in a manner which will prevent damage or deterioration.

9.1.2.2. Unreeling or uncoiling of rope will be done as recommended by rope manufacturers and with extreme care to avoid kinking or inducing a twist.

9.1.2.3. Before cutting a rope, seizings will be placed on each side of the place where the rope is to be cut to prevent unlaying of the strands.

9.1.2.4. During installation, care will be observed to avoid dragging the rope in dirt or around objects which will scrape, nick, crush, or induce sharp bends in it.

9.1.2.5. Rope shall be maintained in a well-lubricated condition. It is important that lubricant applied as part of a maintenance program be compatible with the original lubricant. The rope "manufacturer's instructions" will be consulted. Lubricant applied will be of the type which does not hinder visual inspection. Those sections of rope which are located over sheaves or difficult to see during inspection and maintenance procedures require special attention when lubricating the rope. The object of rope lubrication is to reduce internal friction and to prevent corrosion. **EXCEPTION:** When used in clean rooms, factory lubricant may be removed from stainless steel ropes to prevent contamination.

9.1.2.6. When an operating rope shows greater wear at well defined localized areas than on the remainder of the rope, rope life can be extended in some cases (where a reduced rope length is adequate) by cutting off a section at one end, thus shifting the wear to different areas on the rope.

9.1.2.7. Wherever exposure to temperatures at which fiber cores would be damaged are anticipated, rope having an independent wire-rope or wire-strand core, or other temperature-damage resistant core will be used.

9.1.2.8. Replacement rope will be the same size, grade, and construction as the original rope furnished by the crane manufacturer, unless otherwise recommended by a wire rope manufacturer due to actual working condition requirements. (Also see paragraphs **9.1.2.4.** and **9.1.4.4.**)

9.1.3. Inspection:

9.1.3.1. All running ropes in service shall be visually inspected once each work day. A thorough inspection of all ropes will be made at least once each month and a full, written, dated, and signed report of rope condition kept on file for a minimum of 1 year by the user and readily available. All such inspections shall be performed by a designated person. Any deterioration, resulting in appreciable loss of original strength (such as described below and in paragraph **9.1.4.**) will be carefully noted and should be considered for rejection:

9.1.3.1.1. Reduction of rope diameter below nominal diameter due to loss of core support, internal or external corrosion, or wear of outside wires. Rope calipers and micrometers are normally used to determine changes in wire rope diameters. (See **Figure 9.5.**)

9.1.3.1.2. A number of broken outside wires and the degree of distribution or connection of such broken wires.

9.1.3.1.3. Worn outside wires.

9.1.3.1.4. Sections of rope which are normally hidden or difficult to see during inspection or maintenance procedures (such as parts passing over equalizer sheaves). They will be given close inspection, as these are points most likely to fail.

9.1.3.1.5. Corroded or broken wires at end connections.

9.1.3.1.6. Corroded, cracked, bent, worn, or improperly applied end connections.

9.1.3.1.7. Severe kinking, crushing, cutting, or unstranding.

9.1.3.2. All rope which has been idle for a period of a month or more due to shutdown or storage of a hoist on which it is installed, will be given a thorough inspection before it is placed in service. (Also, see paragraph **9.1.4.3.**)

9.1.4. Replacement:

9.1.4.1. Precise rules to govern replacement of the ropes on lifting devices is impractical. The following conditions will be sufficient reason for questioning rope safety and for possible replacement.

9.1.4.1.1. In running ropes, six randomly distributed broken wires in one rope lay or three broken wires in one strand in one rope lay.

9.1.4.1.2. Wear of one-third the original diameter of outside individual wires.

9.1.4.1.3. Kinking, crushing, bird caging, or any other damage resulting in distortion of the rope structure. (See **Figure 9.6.**)

9.1.4.1.4. Evidence of any heat damage from any cause.

9.1.4.1.5. Reductions from nominal diameter of more than:

9.1.4.1.5.1. One-sixty-fourth of an inch for diameters up to and including five-sixteenths inch.

9.1.4.1.5.2. One-thirty-second of an inch for diameters three-eighths inch to and including one-half inch.

9.1.4.1.5.3. Three-sixty-fourths of an inch for diameters nine-sixteenths inch to and including three-fourths inch.

9.1.4.1.5.4. One-sixteenth of an inch for diameters seven-eighths inch to and including one and one-eighth inch.

9.1.4.1.5.5. Three-thirty-seconds of an inch for diameters one and one-quarter inch to and including one and one-half inch.

9.1.4.1.6. In standing ropes, more than two broken wires in one lay in sections beyond end connections or more than one broken wire at an end connection.

9.1.4.2. Special attention will be given to the end fastenings. Ropes will be examined at socketed fittings and when two broken wires are found next to this point, the rope will be resocketed. Those portions of the rope subjected to reverse bends and operation over small diameter sheaves or drums will be given close attention.

9.1.4.3. A rope which has been in service, but idle for a period of 1 month or more, will be thoroughly examined before it is put back into service. This examination will be for all types of deterioration, particularly, corrosion. This inspection will be performed by a designated person whose approval will be required for further use of the rope. A written and dated report of the rope condition will be maintained by the user for a minimum of 1 year.

9.1.4.4. All replacement rope shall be of proper size, grade, and construction for the particular function it is to perform on the machine. **NOTE**: Discarded rope will not be used for slings.

9.1.4.5. In order to establish data as a basis of judging the proper time for replacement, a continuing inspection record shall be maintained. This record shall cover points of deterioration listed in paragraph **9.1.4.**

9.2. Chains:

9.2.1. Welded Link Chain Inspection:

9.2.1.1. Test the hoist under load in hoisting and lowering directions and observe the operation of the chain and sprockets. Ensure the chain feeds smoothly into and away from the sprockets.

9.2.1.2. If the chain binds, jumps, or is noisy, first ensure it is clean and properly lubricated. If the trouble persists, inspect the chain and mating parts for wear, distortion, or other damage.

9.2.1.3. Clean the chain for inspection. Examine visually for gouges, nicks, weld splatter, corrosion, and distorted links. Slacken the chain and move adjacent links to one side to inspect for wear

at the contact points. If wear is observed, or if stretching is suspected, measure the chain according to the hoist manufacturer's instructions. If instructions are not available, proceed as follows:

9.2.1.3.1. Select an unworn, unstretched length of the chain from the slack end.

9.2.1.3.2. Suspend the chain vertically under tension and, using a caliper type gauge, measure the outside length of any convenient number of links approximately 12 to 14 inches overall.

9.2.1.3.3. Measure the same number of links in the used sections and calculate the percentage increase in length. If the used chain exceeds the hoist manufacturer's recommended length, (or, in the absence of such a recommendation, if the chain is 1.5 percent longer than unused chain) replace the chain. Do not repair load chain by welding or any other means; this repair is only accomplished by the chain manufacturer.

9.2.1.3.4. Install load chain links which pass over the hoist load sprocket on edge (alternate to those which lie flat in the pockets) with the welds away from the center of the sprocket.

9.2.1.4. Inspect hoist chains including end connections for excessive wear, twist, and distorted links interfering with proper function or stretched beyond manufacturer's recommendations. Conduct visual inspection on the day of use; conduct monthly inspection and maintain a record which includes the date of inspection, the signature of the inspector, and an identifier of the inspected chain.

9.2.1.5. When chain is replaced, the mating parts (chain sprockets, guides, stripper) will be disassembled and inspected for wear and replaced if necessary.

9.2.1.6. For non-load bearing drive (slack) chains, inspect for cracks, weld splatter, burrs, or other damage. Repair or replace as required.

9.2.2. Roller Link Chain Inspection:

9.2.2.1. Test the hoist under load in hoisting and lowering directions and observe the operation of the chain and sprockets. Ensure the chain feeds smoothly into and away from the sprockets.

9.2.2.2. If the chain binds, jumps, or is noisy, first ensure it is clean and properly lubricated. If the trouble persists, inspect the chain and mating parts for wear, distortion, or other damage.

9.2.2.3. If possible, inspect the roller link chain while it is in the hoist. With the hoist suspended in normal position apply a light load of approximately 50 pounds.

9.2.2.3.1. Check chain for elongation following the hoist manufacturer's instruction. In absence of specific instructions check the chain by determining the nominal pitch and measuring a 12-inch section of chain that normally travels over the chain sprocket. Using a vernier caliper, check the dimension from the edge of one chain pin to the corresponding edge of another pin for the number of pitches per foot. If elongation exceeds one-fourth of an inch in 12 inches, replace the chain. (For example, a three-fourths inch pitch chain should measure 12 inches over 16 pitches. Reject chain if measurement over 16 pitches exceeds 12.25 inches.)

9.2.2.3.2. Check chain for twist. Replace the chain if the twist in any 5-foot section exceeds 15 degrees.

9.2.2.3.3. Check for camber. Replace chain which has a side bow exceeding one-fourth of an inch in any 5-foot section.

9.2.2.4. Inspect the chain more thoroughly by removing chain from the hoist and cleaning it thoroughly in an acid-free solvent. Then check for any of the following deficiencies:

9.2.2.4.1. Pins turned from their original position.

9.2.2.4.2. Rollers that do not turn freely with light finger pressure.

9.2.2.4.3. Joints that cannot be flexed by easy hand pressure.

9.2.2.4.4. Link plates that are spread open. A visual check of the pin extension at the free end of the chain can determine the amount of spread and the condition of the chain.

9.2.2.4.5. Corrosion, pitting, or discoloration of chain, which is generally indicative of serious impairment.

9.2.2.4.6. Gouges, nicks, or weld spatter.

9.2.3. Maintenance. All chain should be kept clean and free from rust or any coating deposit that will build up and change its dimensions or reduce flexibility. Excessively dirty chain should be soaked in a clean acid-free solvent and agitated to ensure all joints are free from grit and foreign matter. Hand chain normally needs no lubricant. Roller and load chain should be lubricated according to the hoist manufacturer's recommendations. In absence of recommendations, the chain may be lubricated with a good grade of automotive motor oil SAE grade 20-30. Grease will never be applied to a chain.

9.3. Sheaves and Equalizers:

9.3.1. Sheaves:

9.3.1.1. Sheave grooves will be smooth and free from surface defects which could cause rope damage.

9.3.1.2. Sheave-carrying ropes, which can be momentarily unloaded, will be provided with close-fitting guards or other suitable devices to guide the rope back into the groove when the load is applied again. ***Note: Equalizers at which ropes are terminated, shall be specified to have sufficient adjustment space for block leveling as the rope stretches.***

9.3.1.3. The sheaves in the bottom block will be equipped with close-fitting guards that will prevent ropes from becoming fouled when the block is lying on the ground with loose ropes.

9.3.1.4. Pockets and flanges of sheaves used with hoist chains will be of such dimensions that the chain does not catch or bind during operation.

9.3.1.5. All running sheaves will be equipped with means for lubrication. Permanently lubricated, sealed bearings meet this requirement.

9.3.1.6. When chain is replaced, the mating parts (chain sprockets, guides, stripper) will be disassembled and inspected for wear and replaced if necessary.

9.3.2. Equalizers:

9.3.2.1. If a load is supported by more than one part of rope, the tension in the parts will be equalized.

9.3.2.2. Equalizers shall be readily accessible for maintenance, lubrication, and inspection.

9.4. Hooks:

9.4.1. Inspection:

9.4.1.1. Hooks with more than 15 percent of normal throat opening or more than 10 degree twist from the plane of the unbent hook shall be discarded. Repairs by welding or reshaping shall only be done by certified personnel. Repairs will be inspected by suitable crack detecting methods and shall be proof tested to 125 percent. Hooks should not be painted (see paragraph **5.2.5.1.5.**). ***Note: Repairs to hooks used on nuclear certified hoists are not authorized.***

9.4.1.2. Hooks shall be examined for the following (see **Figure 9.7.**):

9.4.1.2.1. Distortion such as bending, twisting, or increased throat opening.

9.4.1.2.2. Wear.

9.4.1.2.3. Cracks, severe nicks, or gouges.

9.4.1.2.4. Safety latch engagement and damaged or malfunctioning latch.

9.4.1.2.5. Hook attachment and securing means.

9.4.1.2.6. Lubrication of swivel point.

9.4.1.2.7. On nuclear certified hoists, perform dye penetrant, magnetic particle, or other suitable NDI on the hook, in addition to the above.

NOTES:

1. If the hook retaining nut is welded to the hook shank, removal of the hook for inspection is not required. In this case, a visual inspection of the inside of the block assembly shall be performed (**Figure 9.8.**). If the block is designed such that disassembly is not feasible, this inspection is not required.

2. See additional annual requirements for nuclear certified hoists in paragraph **5.2.5.2.10.**

9.4.2. Rated Load. Rated load for a hook, when used in the manner for which intended, shall be equal to other suspension members to which it is attached. When this is not feasible, special precautions shall be taken to ensure that the rated load limit of the hook is not exceeded.

9.5. Hydrasets and (or) Load Cells. These devices are used to allow precision placement of heavy loads during mating and demating operations. These precision positioners are especially valuable when handling critical high value items such as spacecraft payloads or astronautical optics. Users of these types of materials handling equipment will develop inspection and testing procedures based upon the type of materials being lifted.

9.6. Personnel Hoists and Suspended Personnel Platforms. The use of a crane or derrick to hoist workers on a personnel platform is prohibited except when conventional means of reaching the worksite, such as personnel hoist, ladder, stairway, aerial lift, elevating work platform or scaffold, would be more hazardous or is not possible. When absolutely necessary to hoist personnel, the following shall apply:

9.6.1. Cranes used for personnel hoisting shall have an anti-two blocking device incorporated into its design and shall have a power controlled lowering system capable of handling rated loads and speeds as specified by the manufacturer. (See 29 CFR 1926.550 for additional information.)

9.6.2. Platforms used to suspend personnel shall be designed and used as follows (see 29 CFR 1926.550 for additional information):

9.6.2.1. Be capable of supporting at least five times the maximum intended load.

9.6.2.2. Be equipped with a guardrail system including a top rail of 42 inches, a midrail, and a toeboard and shall be enclosed at least from the toeboard to the midrail. The guardrails shall be able to withstand at least 200 pounds applied in any direction. A grab rail shall be installed inside the entire perimeter of the platform.

9.6.2.3. Will limit to four the number of workers to be lifted, to include tools. Each worker shall be considered to weigh 250 pounds.

9.6.2.4. Shall not be used during high winds, electrical storms, or any other adverse weather condition which could endanger the workers using the platform.

9.6.3. The lifting bridle, used to suspend the working platform from the crane, shall normally consist of four legs attached so the stability of the platform is ensured. The lifting bridle shall be attached by a hook which can be closed and locked or secured by a shackle with a bolt, nut, and retaining pin. These bridles and associated rigging shall not be used for any other purpose when not hoisting personnel.

9.6.4. The total weight of the loaded personnel platform, the related rigging to include the block, ball, and wire rope shall not exceed 50 percent or the rated capacity for the radius and configuration of the crane or derrick.

9.6.5. The crane shall be uniformly level within 1 percent of level grade and located on firm footing. If equipped, outriggers shall be fully deployed according to manufacturer's specifications.

9.6.6. Requirements for trial lift, inspection, and proof tests follow: (29 CFR 1926.550 for additional information.)

9.6.6.1. Trial lifts are required immediately before personnel are lifted. A new trial lift will be performed any time that the location or the route of the planned lift changes. The platform will be inspected after the trial lift and before lifting personnel.

9.6.6.2. The platform and rigging shall be proof-load tested to 125 percent of the platform's rated capacity prior to lifting personnel at each job location and after any modifications or repairs have been made.

9.6.7. Personnel work practices follow:

9.6.7.1. Workers shall keep all parts of the body inside of the platform during lifts and, except when over water, shall wear and secure a safety belt and (or) harness with lanyard to an approved attach point within the platform. The safety belt and (or) harness lanyard system must prevent a fall of over 6 feet and the attach point must be capable of supporting the fall impact of the worker.

9.6.7.2. The crane or derrick operator shall remain at the controls when personnel are suspended. Operations hoisting personnel will be terminated at the first sign of a potentially dangerous condition.

Figure 9.1. Right and Wrong Way of Using Cable Clips.

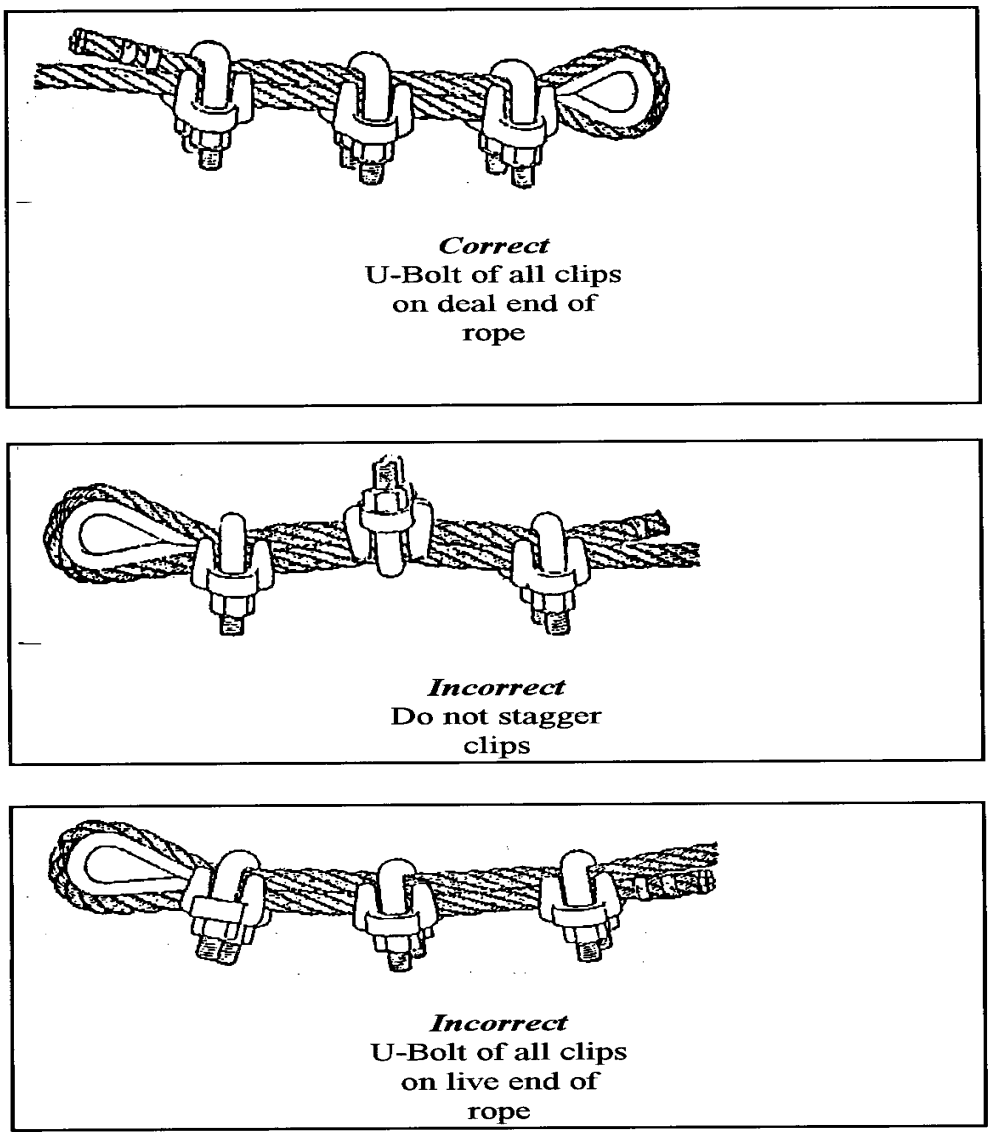
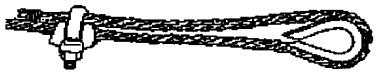


Figure 9.2. Proper Method of Installing Cable Clips.

STEP 1

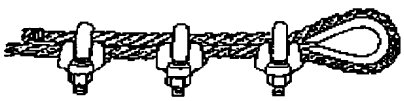


APPLY FIRST CLIP — one base width from dead end of wire rope — U-Bolt over dead and — live end rests in clip saddle. Tighten nuts evenly to recommended torque.

STEP 2

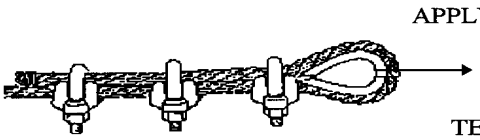
APPLY SECOND CLIP — nearest loop as possible — U-Bolt over dead end — turn on nuts firm but DO NOT TIGHTEN.

STEP 3



ALL OTHER CLIPS — Space equally between first two.

STEP 4



Apply tension and tighten all nuts to recommended torque.

STEP 5

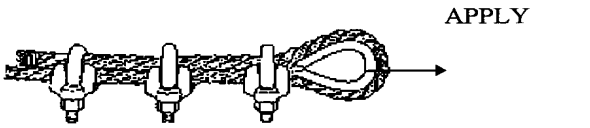


Figure 9.3. Double Base Clamp.

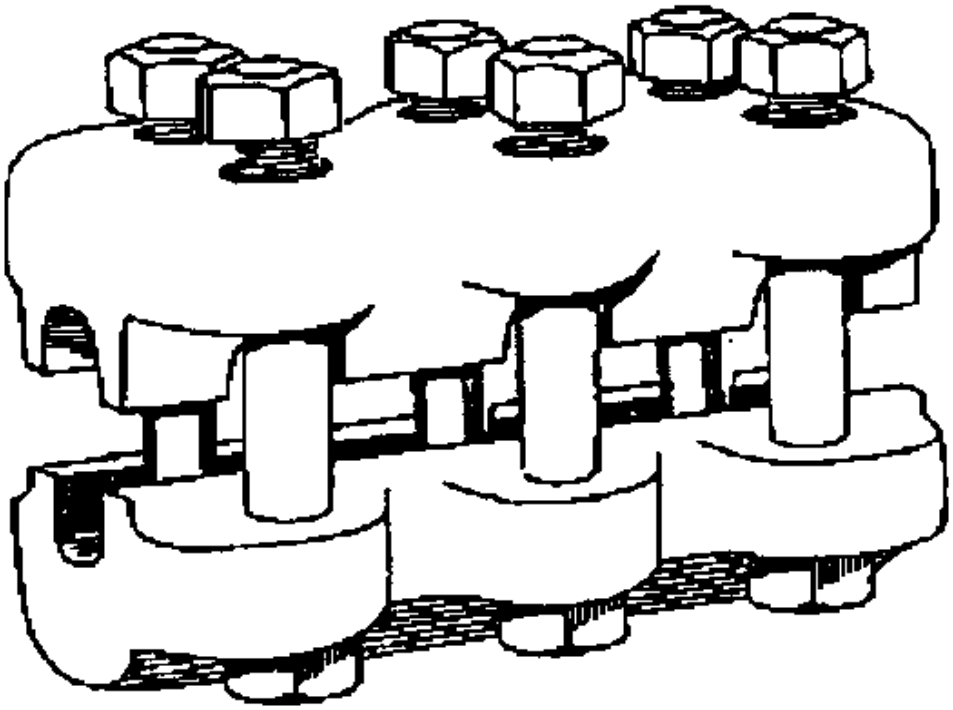


Figure 9.4. Joining Wire Ropes.

WRONG

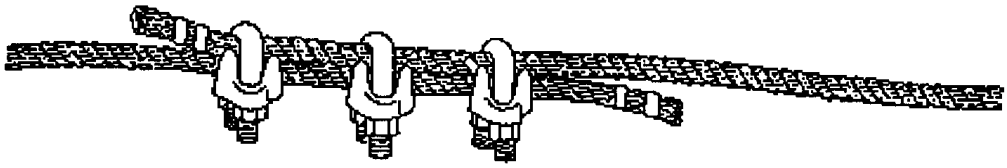


Figure 9.5. Correct and Incorrect Way to Measure Wire Rope. (Always read the widest diameter.)

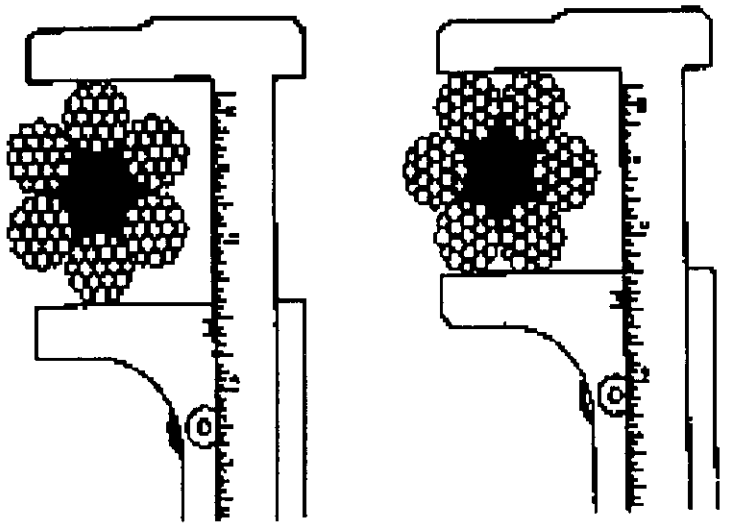


Figure 9.6. Wire Rope Wear and Damage.

A "bird cage" caused by sudden release of tension and resultant rebound of rope from overloaded condition. These strands and wires will not return to their original position.

A wire rope which has jumped a sheave. The rope is deformed into a "curl" as if bent around a round shaft. Close examination of the wires show two types of breaks - normal tensile "cup and cone" breaks and shear breaks which give the appearance of having been cut on an angle with a cold chisel.

A wire rope which has been subjected to repeated bending over sheaves under normal loads. This results in "fatigue" breaks in individual wires — these breaks are square and usually in the crown of the strands.

A wire rope which has been kinked. A kink is caused by pulling down a loop in a slack line during improper handling, installation, or operation. Note the distortion of the strands and individual wires. Early rope failure will undoubtedly occur at this point.

An example of "fatigue" failure of a wire rope which has been subjected to heavy loads over small sheaves. The usual crown breaks are accompanied by breaks in the valleys of the strands —these breaks are caused by "strand nicking" resulting from the heavy loads.

An example of a wire rope that has provided maximum service and is ready for replacement.

A close-up of a rope subjected to drum crushing. Note the distortion of the individual wires and displacement from their normal position. This is usually caused by the rope scrubbing on itself.

A fatigue break in a cable tool drill line caused by a tight kink developed in the rope during operation.

Figure 9.7. Hook Inspection Areas.

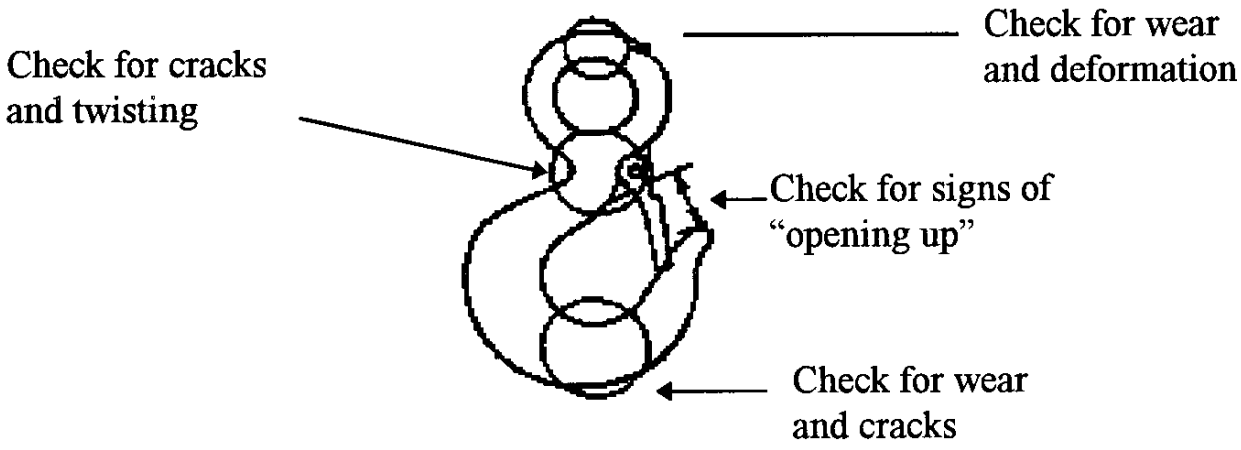


Figure 9.8. Hook Showing Block Interface (Shank).

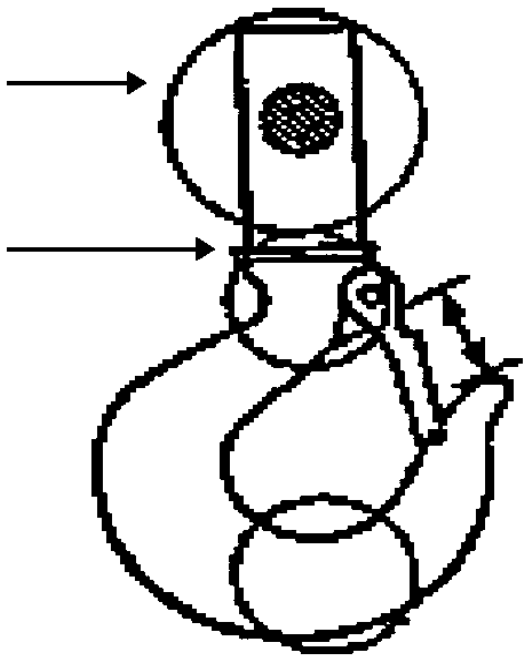


Table 9.1. Number of Spacing of Clips for Ropes of Various Sizes.

Diameter of Rope (inches)	*Minimum Number of Clips*	*Length of Rope Turned Back Exclusive of Eye (inches)*	*Torque (ft-lb)*
1/8	2	3 1/4	--
1/4	2	3 1/4	--
1/2	3	11 1/2	65
5/8	3	12	95
3/4	4	18	130
7/8	4	19	225
1	5	26	225
1 1/8	6	34	225
1 1/4	7	44	360
1 3/8	7	44	360
1 1/2	8	54	360
1 5/8	8	58	430
1 3/4	8	61	590
2	8	71	750
2 1/4	8	73	750

1 in. = 2.54 cm.

1 ft-lb = 1.36 newton-meter.

The number of clips shown is based upon using right regular or Lang lay wire rope, 6x19 class or 6x37 class, fiber core or IWRC, IPS, or XIPS. If Seale construction or similar large outer wire type construction in the 6x19 class is to be used for sizes 1 in. (2.5 cm) and larger, add one additional clip.

The number of clips shown also applies to right regular lay wire rope, 8x19 class, fiber core, IPS, nominal sizes 1 1/2 in. and smaller; and right regular lay wire rope, 18x7 class, fiber core, IPS or XIPS, nominal sizes 1 3/4 in. and smaller.

For other classes of wire rope not mentioned above, it may be necessary to add additional clips to the number shown.

Turn back the specified amount of rope from the thimble. Apply the first clip one base width from the dead end of the wire rope (U-bolt over dead end--live end rests in clip saddle). Tighten nuts evenly to recommended torque.

Apply the next clip as near the loop as possible. Turn on nuts firm but do not tighten.

Space additional clips if required equally between the first two. Turn on nuts--take up rope slack--tighten all nuts evenly on all clips to recommended torque.

NOTES:

1. Apply the initial load and retighten nuts to the recommended torque. The rope will stretch and shrink in diameter when loads are applied. Inspect periodically and retighten.

2. The efficiency rating of a properly prepared termination for clip sizes 1/8 to 7/8 in. is approximately 80 percent and for sizes 1 to 3 in. is approximately 90 percent. This rating is based upon the catalog breaking strength of wire rope. If a pulley is used in place of a thimble for turning back the rope, add one additional clip.

Chapter 10

INSPECTION, TESTING, AND MAINTENANCE OF DERRICKS

10.1. Inspection:

10.1.1. Inspection Classification:

10.1.1.1. Prior to initial use, all new and altered derricks shall be inspected to ensure compliance with the provisions of this standard.

10.1.1.2. Inspection procedure for derricks in regular service is divided into two general classifications based upon the intervals at which inspections shall be performed. The intervals in turn are dependent upon the nature of the critical components of the derricks and the degree of their exposure to wear, deterioration, or malfunction. The two general classifications are herein designated as Frequent and Periodic with respective intervals between inspection as follows:

10.1.1.2.1. Frequent Inspection -- daily or prior to use.

10.1.1.2.2. Periodic Inspection -- one to twelve month intervals or as specified by the manufacturer.

10.1.2. Frequent Inspection. Items such as the following shall be inspected for defects at intervals as defined in paragraph **5.2.5.1.** or as specifically indicated, including observation during operation for any defects which might appear between regular inspections. Deficiencies as listed below shall be carefully examined and a determination made as to whether they constitute a safety hazard:

10.1.2.1. All Control Mechanisms. Inspect daily for adjustment, wear, and lubrication.

10.1.2.2. All Chords and Lacing. Inspect daily.

10.1.2.3. Tension in Guys. Inspect daily.

10.1.2.4. Plumb of the Mast. Inspect daily.

10.1.2.5. Leakage of Air or Deterioration of Hoses, Seals, and Rams of Hydraulic Systems. Inspect daily.

10.1.2.6. Derrick Hooks. Inspect daily for deformations or cracks. For hooks with cracks or having more than 15 percent in excess of normal throat opening or more than 10 degree twist from the plane of the unbent hook, refer to paragraphs **5.2.5.1.5.** and **9.4.1.1.**

10.1.2.7. Rope Reeving. Inspect for noncompliance with derrick manufacturer's recommendations.

10.1.2.8. Hoist Brakes, Clutches, and Operating Levers. Check daily for proper functioning before beginning operations.

10.1.2.9. Electrical Apparatus. Check for malfunction and signs of excessive deterioration, dirt, and moisture accumulation.

10.1.3. Periodic Inspection. Complete inspection of the derrick shall be performed at intervals as generally defined in paragraph **5.2.5.2.** and, in addition, items such as the following will be inspected. Deficiencies shall be carefully examined and a determination made as to whether they constitute a safety hazard.

10.1.3.1. Structural members for deformations, cracks, and corrosion.

10.1.3.2. Bolts or rivets for tightness.

10.1.3.3. Parts such as pins, bearings, shafts, gears, sheaves, drums, rollers, and locking and clamping devices for wear, cracks, and distortion.

10.1.3.4. Gudgeon pin for cracks, wear, and distortion each time the derrick is erected.

10.1.3.5. Power plants for proper performance and compliance with applicable safety requirements.

10.1.3.6. Hooks for cracks and bends, wear and deformations, etc. (refer to **Figure 9.7.**).

10.1.3.7. Foundation or supports for continued ability to sustain the imposed loads.

10.1.3.8. Derrick electrical pendant and (or) control box for proper grounding.

10.2. Derricks Not in Regular Use:

10.2.1. A derrick which has been idle for a period of 1 month or more, but less than 6 months, shall be given an inspection conforming with requirements of paragraph before placing in service.

10.2.2. A derrick which has been idle for a period of over 6 months shall be given a complete inspection conforming with requirements of paragraph **5.2.5.2.** before placing in service.

10.2.3. Standby derricks shall be inspected at least semiannually according to the requirements of paragraph **5.2.5.2.** Those exposed to adverse environment shall be inspected more frequently.

10.3. Testing:

10.3.1. All new derricks will have the manufacturer's certification that all proof-load testing has been accomplished. Prior to initial use, all modified and altered derricks shall be proof-load tested to ensure compliance with this standard, including the following functions:

10.3.1.1. Load hoisting and lowering.

10.3.1.2. Boom up and down.

10.3.1.3. Swing.

10.3.1.4. Operation of clutches and brakes of hoist.

10.3.2. All anchorage shall be approved by the appointed personnel. Rock and hairpin anchorages may require special testing.

10.4. Maintenance:

10.4.1. Preventive Maintenance:

10.4.1.1. A preventive maintenance program based on the derrick manufacturer's recommendations shall be established. Dated and detailed records should be readily available.

10.4.1.2. Replacement parts should be obtained from the original equipment manufacturer.

10.4.2. Maintenance Procedure:

10.4.2.1. Before adjustments and repairs are started on a derrick, the following precautions shall be taken:

10.4.2.1.1. The derrick to be repaired shall be arranged so it will cause the least interference with other equipment and operations in the area.

10.4.2.1.2. All hoist drum dogs shall be engaged.

10.4.2.1.3. The main or emergency switch shall be locked in the open position if an electric hoist is used.

10.4.2.1.4. Warning or "OUT OF ORDER" signs shall be placed on the derrick and hoist.

10.4.2.1.5. The repairs of booms of derricks shall either be made when booms are lowered and adequately supported or when safely tied off.

10.4.2.1.6. A good communication system shall be set up between the hoist operator and the appointed individual in charge of derrick operations, before any work on the equipment is started.

10.4.2.2. Welding repairs shall be approved by the appointed person.

10.4.2.3. After adjustments and repairs have been made, the derrick shall not be operated until all guards have been reinstalled, safety devices reactivated, maintenance equipment removed, and derrick electrical pendant and (or) control box checked for proper grounding.

10.5. Adjustments and Repairs:

10.5.1. Any unsafe conditions disclosed by the inspection and the requirements of paragraphs **10.3.** and **10.4.** shall be corrected before operation of the derrick is resumed. Adjustments shall be maintained to assure correct functioning of components. The following are examples:

10.5.1.1. All functional operating mechanisms.

10.5.1.2. Tie-downs or anchorages.

10.5.1.3. Signal system.

10.5.1.4. Brakes and clutches.

10.5.1.5. Power plants.

10.5.1.6. Guys.

10.5.2. Repairs or replacements shall be provided promptly as needed for safe operation (all replacement and repair parts shall have at least the original safety factor). The following are examples:

10.5.2.1. Hooks showing defects described in paragraph **9.4.** shall be discarded. Repairs by welding or reshaping are not generally recommended. (See **Figure 9.6.**)

10.5.2.2. All critical parts which are cracked, broken, bent, or excessively worn should be replaced.

10.5.2.3. Pitted or burned electrical contacts should be corrected only by replacement and in sets. Controller parts should be lubricated as recommended by the manufacturer.

10.6. Lubrication:

10.6.1. All moving parts of the derrick and hoist, for which lubrication is specified (including rope and chain) shall be regularly lubricated. Lubricating systems shall be checked for proper delivery of lubricant. Particular care should be taken to follow manufacturer's recommendations as to points and frequency of lubrication and maintenance of lubricant to be used.

10.6.2. Machinery shall be stationary while lubricants are being applied unless it is equipped for automatic lubrication.

10.7. Rope Inspection, Replacement, and Maintenance. Refer to **Chapter 9** Particular care shall be taken in the inspection of rotation resistant rope.

ORIN L. GODSEY, Brig General, USAF
Chief of Safety

Attachment 1

GLOSSARY OF REFERENCES, ABBREVIATIONS, ACRONYMS, AND TERMS

References

Air Force Instruction (AFI) 24-301 (formerly designated AFM 77-310, Vol 1), *Vehicle Operations.*

AFI 24-302 (formerly designated AFM 77-310, Vol 2),*Vehicle Maintenance Management.*

AFI 91-202 (formerly designated AFR 127-2), *The US Air Force Mishap Prevention Program.*

AFI 91-301 (formerly designated AFR 127-12), *The Air Force Occupational and Environmental Safety, Fire Protection, and Health (AFOSH) Program.*

Air Force Manual (AFMAN) 23-210, *Joint Service Manual (JSM) for Storage and Materials Handling.*

AFMAN 52-4, *Special Purpose Vehicle Training Manual.*

AFMAN 91-118, *Safety Design and Evaluation Criteria for Nuclear Weapon Systems.*

AFMAN 91-201, *Explosives Safety Standards.*

Air Force Occupational Safety and Health (AFOSH) Standard 48-2 (formerly designated AFOSH Standard 161-2), *Industrial Ventilation.*

AFOSH Standard 91-31 (formerly designated AFOSH Standard 127-31), *Personal Protective Equipment.*

AFOSH Standard 127-22, *Guarding Floor and Wall Openings and Holes, Fixed Industrial Stairs, and Portable and Fixed Ladders.*

AFOSH Standard 127-45, *Hazardous Energy Control and Mishap Prevention Signs and Tags.*

American National Standards Institute (ANSI) Standard A14.3, *Safety Requirements for Fixed Ladders.*

ANSI/American Society of Mechanical Engineers (ASME) Standard B20.1, *Safety Standards for Conveyors and Related Equipment.*

ANSI/ASME Standard B30.2,*Overhead and Gantry Cranes (Top Running Bridge, Multiple Girders).*

ANSI Standard B30.5, *Mobile and Locomotive Cranes.*

ANSI Standard B30.7, *Base Mounted Drum Hoist.*

ANSI/ASME Standard B30.9, *Slings.*

ANSI/ASME Standard B30.10, *Hooks.*

ANSI Standard B30.11, *Monorails and Underhung Cranes.*

ANSI Standard B30.16, *Overhead Hoists (Underhung).*

ANSI Standard B56-1, *Low Lift and High Lift Trucks.*

Department of Defense (DoD) 4145.19-R-1, *Storage and Materials Handling.*

Military Standard (Mil Std) 882, *System Safety Program Requirements.*

National Fire Protection Association (NFPA) 58, *Storage and Handling of Liquefied Petroleum Gases.*

NFPA 70, *The National Electrical Code (NEC).*

NFPA 505, *Industrial Trucks, Powered.*

National Safety Council (NSC), *Accident Prevention Manual for Industrial Operations (Engineering and Technology).*

Occupational Safety and Health Administration (OSHA) Standard 29 Code of Federal Regulations (CFR) 1910.27, *Fixed Ladders.*

OSHA Standard 29 CFR 1910.107, *Spray Finishing.*

OSHA Standard 29 CFR 1910.108, *Dip Tank Conveyors.*

OSHA Standard 29 CFR 1910.176, *Handling Materials--General.*

OSHA Standard 29 CFR 1910.177, *Servicing Multi-Piece and Single Piece Rim Wheels.*

OSHA Standard 29 CFR 1910.178, *Powered Industrial Trucks.*

OSHA Standard 29 CFR 1910.179, *Overhead and Gantry Cranes.*

OSHA Standard 29 CFR 1910.180, *Crawler, Locomotive, and Truck Cranes.*

OSHA Standard 29 CFR 1910.184, *Slings.*

OSHA Standard 29 CFR 1910.218, *Forging Machine Conveyors.*

OSHA Standard 29 CFR 1910.251, *Rigging Equipment for Material Handling.*

OSHA Standard 29 CFR 1910.263, *Bakery Equipment Conveyors.*

OSHA Standard 29 CFR 1910.265, *Sawmill Conveyors.*

OSHA Standard 29 CFR 1926.550, *Cranes and Derricks.*

OSHA Standard 29 CFR 1926.552, *Material Hoists, Personnel Hoists, and Elevators.*

OSHA Standard 29 CFR 1926.553, *Base Mounted Drum Hoist.*

Technical Order (TO) 00-11ON-16, *Equipment Authorized for Use with Nuclear Weapons.*

TO 00-20B-5, *USAF Motor Vehicle and Vehicle Equipment Inspection.*

TO 00-85-20, *Engine Shipping Instruction.*

TO 32-1-101, *Use and Care of Hand Tools.*

TO 36-1-23, *Serviceability Standards, USAF Vehicles.*

TO 36C-1-4, *Electrocution Protective and Proximity Warning Devices for Cranes, Crane Shovels, Line Maintenance Derrick Trucks, and Dielectric Testing of Insulated Aerial Manlift Devices.*

TO 36C-1-5, *60 Rules on Safety.*

TO 36M-1-141 463L, *Material Handling Equipment Systems.*

Abbreviations and Acronyms

AFI—Air Force Instruction (new designation)

AFM—Air Force Manual (old designation)

AFMAN—Air Force Manual (new designation)

AFOSH—Air Force Occupational Safety and Health

AFPAM—Air Force Pamphlet

AFPD—Air Force Policy Directive

AFR—Air Force Regulation (obsolete designation)

AFSC—Air Force Safety Center

AFTO—Air Force Technical Order

ANSI—American National Standards Institute

ASME—American Society of Mechanical Engineers

BE—Bioenvironmental Engineering

C—Celsius

CFR—Code of Federal Regulations

CG—Center of Gravity

CMAA—Crane Manufacturer's Association of America, Inc.

DoD—Department of Defense

DRU—Direct Reporting Unit

F—Fahrenheit

FC—Fiber Core

FOA—Field Operating Agency

HQ—Headquarters

IWRC—Independent Wire Rope Core

JSA—Job Safety Analysis

JSM—Joint Service Manual

kV—Kilovolts

LP—Liquid Petroleum

MAJCOM—Major Command

MHE—Materials Handling Equipment

Mil Std—Military Standard

NDI—Non-Destructive Inspection

NEC—National Electrical Code

NFPA—National Fire Protection Association

NSC—National Safety Council

OSHA—Occupational Safety and Health Administration

PPE—Personal Protective Equipment

SAE—Society of Automotive Engineers, Inc.

SA-ALC—San Antonio Air Logistics Center

TO—Technical Order

Terms

Shall—Indicates a mandatory requirement.

Will—Is also used to indicate a mandatory requirement and in addition is used to express a declaration of intent, probability, or determination.

Should—Indicates a preferred method of accomplishment.

May—Indicates an acceptable or satisfactory method of accomplishment.

Definitions— Definition of terms used in the standard are included in this section. ***NOTE:*** Definitions of common-usage terms not actually used in the standard, but which may be encountered by materials handling and storage personnel in other documents, are at **Attachment 2**.

463L Equipment— Specialized material handling equipment designed for on- and off-loading cargo from aircraft. It includes specially constructed pallet conveyor platforms.

Actuator—A manually operated device used to initiate controls or operator action. An actuator includes, but is not limited to, a push button, toggle switch, foot pedal, hand lever, and a hand set timer.

Administrative or Regulatory Authority— Governmental agency or the employer in the absence of governmental jurisdiction.

Aisle— Any passageway in the storage area.

Angle Indicator (Boom)— An accessory which measures the angle of the boom to the horizontal.

Appointed— Assigned specific responsibilities by the supervisor or the authorized user agency.

Approved —Accepted as satisfactory by a duly constituted administrative or regulatory authority.

Attachment (Forklift)— A device other than conventional forks or load back rest extension for handling the load, mounted permanently or removable on the elevating mechanism of a truck.

Authorized— Approved by a duly constituted administrative or regulatory authority.

Automatically Controlled— Operation by the action of its mechanism being initiated by some design feature, such as a conveyor which is started by a low-level bin indicator.

Automatic Unit— A unit which, when activated, operates through a preset cycle or cycles.

Auxiliary Hoist— A supplemental hoisting unit of lighter load capacity and usually higher speed than provided by the main hoist.

Backrest Extension (Forklift)— A device extending vertically from the fork carriage to keep cargo from falling rearward.

Bars— The load carrying member mounted between two trolleys or two trolley yokes.

Belt Conveyor— An endless fabric, rubber, plastic, leather, or metal belt operating over suitable drive,

tail end, and bend terminals and over belt idlers or slider bed for handling bulk materials, packages, or objects placed directly upon the belt.

Belt Idler— A roller or series of rollers which support the belt of a belt conveyor.

Boom— A cantilevered member or structure which may be hinged, fixed, or pivoted.

Boom Angle— The angle between the longitudinal centerline of the boom and the horizontal. The boom longitudinal centerline is a straight line between the boom foot pin (heel pin) centerline and the boom point sheave pin centerline.

Boom (Crane)— A member, fixed or telescoping, hinged to the rotating superstructure and used to support the hoisting tackle.

Boom Hoist—A hydraulic or mechanical hoist drum and rope reeving system used to raise and lower the boom. The rope system may be all live reeving or a combination of live reeving and pendants.

Boom Stop— A device used to limit the angle of the boom at the highest position.

Braided Wire Rope— A wire rope formed by plaiting (braiding) component wire strands.

Brake—A friction device for slowing down a conveyor component, bringing conveyor equipment to a controlled stop, holding traveling or traversing equipment in a selected location, for preventing reverse travel, and for controlling overspeed due to the action of gravity.

- *Brake, Drag.*A brake which provides retarding force without external control.
- *Brake, Holding.*A brake that automatically prevents motion when power is off.
- *Brake, Travel.*A brake that retards or stops motion in a horizontal direction.

Bridge— That part of a crane consisting of girders, trucks, end ties, footwalks, and drive mechanism which carries the trolley or trolleys.

Bridgeplate—A plate, usually of metal and having a rated load capacity, used to span the space between freight cars or trucks and the loading platform. Also known as dockboard.

Bridge Travel— Crane movement in a direction parallel to the crane runways.

Bumper (Buffer)— An energy absorbing device for reducing impact when a moving crane or trolley reaches the end of its permitted travel; when two moving cranes or trolleys come in contact.

Cab—

- The operator's compartment attached to the crane or monorail carrier in which the operator may ride and from which the motions of the crane or monorail equipment may be controlled.
- A housing which covers the rotating superstructure machinery or operator's station. On truck-crane trucks, a separate cab covering the driver's station.

Cable Laid Endless Sling Mechanical Splice— A wire rope sling made endless by joining the ends of a single length of cable laid rope with one or more metallic fittings.

Cable Laid Grommet Hand Tucked— An endless wire rope sling made from one length of rope wrapped six times around a core formed by hand-tucking the ends of the rope inside the six wraps.

Cable Laid Rope Sling Mechanical Splice— A wire rope sling made from a cable laid rope with eyes fabricated by pressing or swaging one or more metal sleeves over the rope junction.

Cable Laid Wire Rope— A wire rope composed of six wire ropes wrapped around a fiber or wire rope core.

Cab-Operated— Crane or monorail equipment, the motions of which are controlled from an operator's cab.

Carrying Methods —Following are descriptions of various types of carrying methods:

- *Neck Carry Method.* In this method, the material is carried on the back of the neck and shoulders with both arms lifted to shoulder height and the hands grasping the sides or top of the load.
- *Shoulder Carry Method.* The load rests on one shoulder with the near arm helping to support the weight and the other arm brought across the body to steady the load.
- *Side Hand Carry Method.* This is simply the suitcase method and can be used only where the load may be grasped by a handle or the equivalent.
- *Tray Carry Method.* The material is carried in front of the abdomen with both hands placed under the bottom surface and the body serving as the balancer.
- *Two Person Carry Method.* A load is carried by two people who use oral signals to coordinate their movements. They decide on appropriate emergency signals to be given if the grasp of either person should slip. They walk in step to coordinate their movements.
- *Under-Arm Carry Method.* The material is carried under one arm with the other arm brought across in front of the body to steady and balance the load. (Also called Side Under-Arm Carry Method).

Chain—A series of links pivotally joined together to form a medium for conveying or transmitting motion or power. General classes of chain common to the conveyor art are: detachable, pintle, combination, roller, rivetless, coil, inverted tooth, and bar link chains.

- *Chain, Roller Link.* A chain consisting of a series of stamped steel plates fastened with pins, bushings, and rollers giving articulation in only one plane.
- *Chain, Welded Link.* A chain consisting of a series of interwoven links formed and welded from round bar stock.

Checker Plate Flooring— Metal flooring embossed with high and low points pressed into metal to create a non-skid surface.

Clearance— The distance from any part of material handling equipment to a point of the nearest obstruction.

Coaming (Toeboard)— Raised sides on a platform installed to prevent tools and small items from falling off.

Coating— An elastomer or other suitable material used to impart physical, electrical, or other desired properties when applied to a sling or sling component.

Collectors, Current— Contacting devices for collecting current from runway or bridge conductors.

Collector Shoe— That portion of a current collector that makes contact by sliding on the conductor bar or wire.

Conductor— A substance or device that readily conducts heat, electricity, sound, etc. Definitions of specific conductors follow:

- *Conductors, Bridge*. The electrical conductors located along the bridge structure of a crane to provide power to the trolley.
- *Conductors, Enclosed.* Bar or wire used to transmit electricity, enclosed to minimize the possibility of accidental contact with the conductor.
- *Conductors, Open.* Bar or wire not enclosed, used to transmit electrical current and provide power (frequently used with the crane or monorail carrier).
- *Conductors, Runway (Main).* The electrical conductors located along a crane runway to provide power to the crane.

Conveyor— A horizontal, inclined, or vertical device for moving or transporting bulk material packages, or objects, in a path predetermined by the design of the device, and having points of loading and discharge, fixed or selective. Included are skip hoists and vertical and inclined reciprocating conveyors. Typical exceptions are those devices known an industrial trucks, tractors, and trailers, tiering machines, cranes, hoists, power shovels, power scoops, bucket drag lines, platform elevators designated to carry passengers or the operator, manlifts, moving walks, moving stairways, highway or rail vehicles, cableways, tramways, pneumatic conveyors, or integral machine transfer devices.

Conveyor Belt— A belt used to carry materials and transmit the power required to move the load being conveyed.

Countertorque— A method of control by which the power to the motor is reversed to develop torque in the opposite direction. Also used to slow or stop motion.

Counterweight — A weight used to balance or counter a load. Examples are:

- Additional weight usually attached to the rear of the forklift to provide better weight distribution.
- Weight used to supplement the weight of the crane in providing stability for lifting working loads.

Control— The system governing the starting, stopping, direction of motion, acceleration, speed, retardation, and function of the moving member in a predetermined manner.

Control Braking— A method of controlling motor speed when in an overhauling condition, i.e., as in a crane motor.

Control Voltage—The voltage passing through the operator's push-button station or the controller and the control circuits.

Controller— An electro-mechanical device or assembly of devices for starting, stopping, accelerating, or decelerating a system, or which serves to govern in some predetermined manner the electric power delivered to the system.

Controller, Electric— An electric controller is a device or group of devices which serves to govern, in some predetermined manner, the electric power delivered to the apparatus to which it is connected.

Controller, Spring Return— A controller which when released will return automatically to a neutral position.

Crane—Any machine for lifting and (or) lowering of a load and moving it horizontally, in which the lifting device is an integral part of the machine. Refer to **Attachment 2** for definitions of specific types of cranes not defined below.

- *Crane, Cantilever Gantry.* A gantry or semigantry crane in which the bridge girders or trusses extend transversely beyond the crane runway on one or both sides.

- *Crane, Crawler.* A crane consisting of a rotating superstructure with power plant, operating machinery, and boom, mounted on a base, equipped with crawler treads for travel.
- *Crane, Floor-Operated.* A crane which is controlled by an operator on the floor or an independent platform by using a pendant or nonconductive rope.
- *Crane, Gantry.* A crane similar to an overhead crane except the bridge for carrying the trolley or trolleys is rigidly supported on two or more legs running on fixed rails or other runway.
- *Crane, Overhead.* A crane with a movable bridge carrying a movable or fixed hoisting mechanism and traveling on an overhead fixed runway structure.
- *Crane, Remote-Operated.* A crane controlled by an operator not in a cab or pulpit. It is controlled by any method other than pendant or rope control (for example: radio, voice, remote hydraulic control, etc.).
- *Crane, Storage Bridge.* A gantry type crane of long span usually used for bulk storage of material; the bridge girders or trusses are rigidly or nonrigidly supported on one or more legs. It may have one or more fixed or hinged cantilever ends.
- *Crane, Underhung.* A traveling bridge on two or more runway tracks on which hoists and carriers may travel for the purpose of lifting, transporting, and lowering loads. It is suspended under its runway tracks system, the trolley of which operates on the bottom flange of the track.
- *Crane, Wall.* A crane having a jib with or without trolley and supported from a side wall or line of columns of a building. It is a traveling type and operates on a runway attached to the side wall or columns.

Critical Loads— Loads that include, but are not limited to, high value ordnance items, missile or spacecraft hardware and components and any unique, high value items identified by program or functional managers.

Crossover— A connecting track with an interlock mechanism on both ends mounted between two interlocking cranes used to transfer a carrier from one bridge to the other.

Cross Rod —A wire used to join spirals of metal mesh to form a complete fabric.

Derrick— An apparatus consisting of a mast or equivalent member held at its upper end by guys or braces, with or without a boom, for use with hoisting mechanism and operating ropes. (Refer to Attachment 4 for descriptions of specific derricks.)

Designated— Selected or assigned by the employer or the employer's representative as being qualified to perform specific duties.

Dielectric Boom Shield— An insulating device installed on booms to provide electrocution protection to operators and load handlers.

Drive—An assembly of the necessary structural, mechanical, and electrical parts which provides the motive power for a conveyor, monorail, crane, etc.

Drop Section— A mechanism which will permit a section of track to be lowered out of alignment with a stationary track.

Drum:—

- A cylindrical or polygonal rim type of wheel around which cable, chain, belt, or other linkage may be wrapped. A drum may be driven or driving. The face may be smooth, grooved, fluted, or flanged;
- A cylindrical or bilged shipping container having straight sides and flat or bumped ends, designed for storage and shipment as an unsupported outer package that may be shipped without boxing or crating.

Equalizer —A device which compensates for unequal length or stretch of a rope.

Exposed— Capable of being contacted inadvertently; applies to hazardous objects not adequately guarded or isolated.

Fabric (Metal Mesh) —The flexible portion of a metal mesh sling consisting of a series of transverse coils and cross rods.

Fail-Safe—A provision designed to automatically stop or safely control any motion in which a malfunction occurs.

Footwalk —A walkway with handrail, attached to the bridge or trolley for access purposes.

Fork Extensions— Steel extensions which fit over the forks to extend the reach of the forklift. The use of extension extends the reach but reduces the capacity of the forklift.

Fork Height— The vertical distance from the ground to the load carrying surface adjacent to the heel of the forks with the mast vertical and forks extended.

Forks and (or) Tines— Horizontal steel projections, normally suspended from the carriage of a forklift truck, used to engage loads.

Handle— A terminal fitting to which metal mesh fabric is attached.

Hand Chain Wheel— A wheel with formed pockets on its periphery to allow torque to be transmitted to the hoist when a force is applied to the hand chain.

High-Lift Platform Truck — A truck equipped with a load platform, intended primarily for transporting and tiering loaded skid platforms.

High-Lift Truck— A truck designed to permit stacking material in tiers. Types in this category are high-lift fork truck, high-lift ram truck, high-lift boom truck, high-lift clamp truck, and high-lift platform truck.

Hitch— A sling configuration whereby the sling is fastened to an object or load, either directly to it or around it.

- *Basket Hitch.* A sling configuration where the sling is passed under the load and has both ends, end attachments, eyes or handles on the hook or single master link.
- *Choker Hitch.* A sling configuration with one end of the sling passing under the load and through an end attachment, handle, or eye on the other end of the sling. Used for turning an object.
- *Vertical Hitch.* A method of supporting a load by a single vertical part or leg of the sling.

Hoist — Includes only those components furnished by the hoist manufacturer; such as drums tackle, prime movers, limiting device, mounting bases, etc. When hoists are mounted as integral parts of more complex lifting equipment, they become component parts of that equipment. They are subject to the safety standards and inspection intervals established for the end item.

Hoist Chain— The load bearing chain in a hoist.

Hoist Motion— That motion of a crane which raises and lowers a load.

Hook, Latch Type— A safety hook incorporating a device to bridge the hook opening which requires manual movement to release the load from the hook.

Inclined Reciprocating Conveyor— A reciprocating power or gravity actuated unit which receives only inanimate objects on a track, roller, conveyor, or other form of carrying surface not designed to carry passengers or the operator. These units operate on inclines generally in the range of 30 degrees to 70 degrees with the horizontal.

Interlock— A mechanical device to align the adjacent ends of two cranes or a crane and spur track to permit the transfer of carriers from one to the other.

Internal Combustion Engine Truck— A truck powered by a gasoline, diesel, or liquid petroleum (LP) gas-powered internal combustion engine.

Lay— The linear distance for one strand to go completely around a rope.

Lift Section — A mechanism which will lift a section of track out of alignment with a stationary track.

Limiting Device— A mechanical or electrical device which is designed to limit motion.

Limit Switch—A switch which is operated by some part of the hoist or equipment to alter the electrical circuit associated with the hoist or equipment to limit travel of lifting option to prevent hoist or equipment damage.

Load—The total weight superimposed on the load block, hook, or carrier.

Load Block (Lower)— The assembly of hook or shackle, swivel, sheaves, pins, bearings, and frame suspended by the hoisting ropes or chains.

Load Block (Upper)— The assembly of hook or shackle, swivel, sheaves, pins, and frame suspended from the boom point.

Load Hoist—A hoist drum and rope reeving system used for hoisting and lowering loads.

Load Ratings— Crane ratings in pounds established by the manufacturer as safe working loads at various boom radii.

Loading Platform —A flat surface for loading or unloading cargo, usually erected alongside a warehouse approximately the same height as the bed of a truck or railcar.

Load (Working)— The external load, in pounds applied to the crane, including the weight of load-attaching equipment such as load blocks, shackles, slings, and ropes.

Locomotive Crane— A crane consisting of a rotating superstructure with power plant, operating machinery, and boom, mounted on a base or car equipped for travel on railroad track. It may be self-propelled or propelled by an outside source.

Low-Lift Truck— A truck designed to raise a load sufficiently to permit horizontal movement. Examples are the low-lift platform truck and the pallet truck.

Magnet— An electromagnetic device carried on a hoist hook, used to pick up and carry loads magnetically.

Man-Rated— A crane specifically configured or designed and built for raising and lowering personnel in work cages or baskets, having a positive controlled powered lowering system, upper limit switch, and dead-man controls.

Mast— A vertical support guide on a forklift truck which permits vertical movement of the forks.

Mechanical— A method of control by friction.

Monorail— An overhead track upon which carriers travel to transport loads.

Motorized Hand Truck— A truck designed to be controlled by a walking operator.

Nuclear Certified Equipment— Equipment that is nuclear certified and listed in TO 00-11ON-16. The single point of contact for Air Force to certify equipment for use with nuclear weapons is HQ AFSC/SEWA. This office, in coordination with the Director of Nuclear Weapons Directorate (SA-ALC/NWTD), Kelly AFB TX), establishes the equipment as certified and ensures the equipment is listed in TO 00-11ON-16.

Operational Test—A test of mechanical and electrical controls, limit switches, and safety devices through the complete operational range without a load.

Operator's Station—Location at which actuators are placed for the purpose of starting, stopping, reversing, or otherwise controlling the conveyor or system of conveyors in the course of normal operation.

Order (Stock) Picker Truck, High Lift— A high-lift truck with the operator’s station attached to the forks. The station and forks move as a unit. The truck is intended for manual stock selection but may be capable of self-loading or tiering.

Overhead Guard—A protective framework fitted to a truck over the head of the operator.

Overload Device— A mechanical or electrical device designed to disconnect the driven equipment from the motive power in the event of an overload on the conveyor.

Overtravel Restraint— Any device used to prevent the slack load chain from inadvertently being lowered out of the load sprocket.

Outriggers—Extendible or fixed metal arms, attached to the mounting base, which rest on supports at the outer ends.

Pallet— A low portable platform of wood, metal, or fiberboard used to stack, move, store, and transport supplies as a unit.

Pawl (Dog)— A device for positively holding the mechanism, drum, etc., against undesired rotation.

Pendant Station— Controls suspended from the hoist for operating the unit from the floor or portable "plug-in" pendant controls.

Platform— A working space for persons who are elevated above the surrounding floor or ground, such as a balcony for the operation of machinery and equipment.

Power and Free Conveyor —A conveying system wherein the load is carried on a trolley or trolleys which are conveyor propelled through part of the system and may be gravity or manually propelled through another part. This arrangement provides a means of switching the free trolley into and out of adjacent lines. The spur or subsidiary lines may or may not be powered.

Power Controlled Lowering— A system or device in the power train other than the load hoist brake, which can control the lowering rate of speed of the load hoist mechanism.

Proof Load (Crane)— A 110 percent test of the maximum load as designated by the manufacturer of a crane in which the proof load is hoisted, held for a predetermined time (commonly 3-5 minutes), raised again, held, lowered, held again, and then lowered to the ground.

Proof Load (Hoist)— A 125 percent test of the maximum load designated by the manufacturer of a hoist in which the proof load is hoisted, held for a predetermined time (commonly 3-5 minutes), raised again, held, lowered, held again, and then lowered to the ground.

Proof Test— A nondestructive tension test performed to verify construction, workmanship, and load capability of a sling.

Proximity Warning Device —A device installed on booms which alerts or warns the operator when the boom is in proximity to energized electric power lines.

Pulpit Operated— A crane or unit operated from a fixed operator station not attached to the unit.

Push-button Station —An electrical control device consisting of push-button operated contacts in an enclosure used by the operator for control of the powered motions of the crane, hoist, and other auxiliary equipment.

Qualified Engineer— A person who, by possession of a recognized degree, certificate, or professional standing or who, by extensive knowledge, training, and experience has successfully demonstrated ability to solve problems relating to the subject matter and work.

Rail—

- One of the longitudinal members in a conveyor frame;
- The supporting surface under the wheels or rollers of a chain conveyor; or
- The supporting track for equipment mounted on wheels such as belt tripper, weigh larry, etc.

Rail Clamp—An attachment or device for clamping movable equipment to the rail to hold it in a fixed location.

Rail Stop—A stop mounted at the ends of conveyor rails to limit the travel of traversing machinery.

Ratchet—A toothed member for engagement of the pawl.

Rated Load (Capacity)— The maximum load, designated by the manufacturer or qualified engineer, for which the equipment or system is designed and built.

Rated Load Test— A 100 percent minimum load test of the maximum load as designated by the manufacturer of the crane in which the load is hoisted, held for a predetermined time (commonly 3-5 minutes), raised again, exercised through its operational envelope at the manufacturer's recommended boom angles, lowered, held again, and then lowered to the ground.

Reach— The effective length of an alloy steel chain sling measures from the top bearing surface of the upper terminal component to the bottom bearing surface of the lower terminal component.

Reach Truck —A self-loading truck, generally high-lift, having load-engaging means mounted so it can be extended horizontally forward. This permits a load to be picked up and deposited in the extended position and transported in the retracted position.

Reciprocating Conveyor— Any conveyor that progressively advances material by a back and forth motion of its conveying medium. It may be equipped with hinged flights or tilting dogs or pushers.

Reeving— A system in which a rope or chain travels around drums, sheaves, or sprockets.

Remote Control —A control station or any system of controls in which the actuator is situated in a remote location and is not mechanically attached to the device being controlled.

Roller—

- A revolving cylinder or wheel over which something is moved. The face may be straight, tapered, crowned, concave, flanged, corrugated, ribbed, or fluted;
- A component part of a roller chain which serves only to reduce frictional loss occurring as the chain passes over the sprockets. Rollers may also serve as the rolling support for the chain and the load being conveyed; or
- The rotating element upon which a conveyor belt or chain or the object being transported is carried (refer to belt idler).

Roller Conveyor—

- A series of rollers supported in a frame over which objects are advanced manually, by gravity, or by power.
- A series of rollers over which objects are moved by the application of power to all or some of the rollers. The power transmitting medium is usually belting or chain.

Rope —Refers to wire rope unless otherwise specified.

Runway— The track and supports (rails, beams, girders, brackets, and framework) system upon which the crane or trolley travels.

Safety Device —A mechanism or an arrangement placed in use for the specific purpose of preventing an unsafe condition, preventing the continuation of an unsafe condition, warning of an unsafe condition, or limiting or eliminating the unsafe effects of a possible condition.

Selvage Edge—The finished edge of synthetic webbing designed to prevent unraveling.

Seizing— The cord, tape, or wire wrapped around a rope to prevent it from unraveling when it is cut in two.

Sheave— A grooved wheel or pulley used with a rope to change direction and point of application of a pulling force.

- *Sheave, Non-running.* A sheave used to equalize tension in two parts of the rope. Because of its slight movement, it is not termed a running sheave.
- *Sheave, Running.* A sheave which rotates as the load block is raised or lowered.

Shield— A full or partial enclosure or cover, either framed or solid, made from material sufficiently rigid to prevent accidental contact.

Side Loader —A truck, generally a high-lift, having a load engaging means mounted in such a manner that it can be extended laterally to permit a load to be picked up and deposited in the extended position and transported in the retracted position.

Side Loading— A load applied at an angle to the vertical plane of the boom.

Side Pull— That portion of the hoist pull acting horizontally when the hoist lines are not vertical.

Sling— An assembly which connects the load to the material handling equipment. Also known as bridle.

Spiral— A single transverse coil that is the basic element from which metal mesh is fabricated.

Sprocket —A wheel with suitably shaped and spaced cogs or teeth to engage with the links of a chain.

Sprocket, Load— The hoist component that transmits motion to the load chain. Component is sometimes called load wheel, load sheave, or chain wheel.

Standby Crane— A crane not in regular service but which is used occasionally or intermittently as required.

Standing (Guy) Rope— A supporting rope which maintains a constant distance between the points of attachment to the two components connected by the rope.

Stop— A device to limit travel of a trolley or crane bridge. This device normally is attached to a fixed structure and does not have energy absorbing ability.

Stop Switch, Emergency— A manually or automatically operated electric switch to cut off electric power independently of the regular operating controls.

Straddle Lift Truck— A general class of lift truck designed for picking up and hauling loads between its outrigger arms.

Strand Laid Endless Sling - Mechanical Joint —A wire rope sling made endless from one length of rope with the ends jointed by one or more metallic fittings.

Strand Laid Grommet - Hand Tucked—An endless wire rope sling made from one length of strand wrapped six times around a core formed by hand-tucking the ends of the strand inside the six wraps.

Strand Laid Rope—A wire rope made with strands (usually six or eight) wrapped around a fiber core, wire strand core, or independent wire rope core (IWRC).

Stripper— A device that aids the load chain in leaving the load sprocket.

Superstructure— The rotating upper frame structure of the machine and the operating machinery mounted thereon.

Swing— Rotation of the superstructure for movement of loads in a horizontal direction about the axis of rotation.

Switch—

- A control device for making, breaking, or changing connections in an electric circuit;
- Any device for connecting two or more continuous package conveyor lines;
- A mechanism which transfers a trolley, carrier, or truck from one track to another at a converging or diverging section.

Switch, Limit— A switch which is operated by some part or motion of a power-driven machine or equipment to alter the electric circuit. The purpose is generally to limit the travel of a machine or equipment component.

Switch, Main—A switch controlling the entire power supply to a system.

Switch, Track —A device with a moving section of track which can be moved to permit passage of a

carrier from an incoming track to one of the various outgoing tracks.

Tag Line— A manila or synthetic rope used to prevent a load from swinging or rotating.

Tiering—The process of placing one load on or above another.

Track— The structural member upon which the carriers or crane wheels operate.

Tracks— The beams, shapes, or formed section on which trolleys, rollers, shoes, or wheels roll or slide while being propelled.

Track Opener —Sections of monorail track arranged to lift or swing out of the line of track to make an opening through which a door may pass.

Tramrail— Same as Monorail.

Travel— The function of the machine moving from one location to another.

Tread Plate— A plate of suitable size fitted between conveyor rollers to permit persons to use it as a working or walking surface or safety guard.

Trolley—

- An assembly of wheels, bearings, and brackets used for supporting and moving suspended loads or for carrying load connecting and conveying elements such as chain, cable, or other linkage;
- The unit carrying the hoist mechanism which travels on overhead bridge rails; or
- A frame on which a pair of load carrying wheels are mounted.

Trolley Conveyor —A series of trolleys supported from or within an overhead track and connected by endless propelling means such as chain, cable, or other linkage with loads usually suspended from the trolleys.

Truck—

- An assembly which supports another unit in either a fixed or adjustable position and which provides mobility; or
- A wheeled vehicle which can be detached from a conveying medium (usually chain) and pushed by hand.

Truck Crane— A crane consisting of a rotating superstructure with power plant, operating machinery, and boom mounted on an automotive truck equipped with a power plant for travel. Some variations use a single engine in the truck which also is the power source for the superstructure, or a single engine in the superstructure which also is the power source for the truck.

Turntable— A track device with a movable liner frame containing a straight section of track which can be rotated with a load carrier on it to align the section of track with other tracks for the transfer of carriers from one track to another.

Two-Blocking— When the lower load block comes in contact with the upper load block or boom point.

Vertical Reciprocating Conveyor— A reciprocating power or gravity actuated unit which receives only inanimate objects on a track, roller conveyor, or power conveyor forming the bed of the carrier and transmits these inanimate objects vertically from one elevation to another.

Warehouse Tractor or Tug— An industrial vehicle designed to draw one or more nonpowered trailers.

Attachment 2

SIGNIFICANT REFERENCES (GLOSSARY OF COMMON-USAGE TERMS NOT USED IN THIS STANDARD)

Antirunway. A safety device to stop a declining conveyor in the event of a mechanical or electrical failure.

Apron Pan. One of a series of overlapping or interlocking plates or shapes which, together with others, forms the conveyor bed.

Automatic Crane. A crane which when activated operates through a preset cycle or cycles.

Axis of Rotation. The vehicle axis around which the crane superstructure rotates.

Backstop. A mechanical device to prevent reversal of a loaded conveyor under action of gravity when forward travel is interrupted.

Base Mounted Hoist. A power driven drum or drums capable of lifting and lowering loads.

Battery-Electric Truck. A truck powered with a storage battery or batteries.

Bed:

- The part of a conveyor upon which the load- or carrying-medium rests or slides while being conveyed;
- In bulk material conveyors, the mass of material being conveyed.

Belt Tripper. A device incorporating a system of pulleys which causes the conveyor belt to discharge material at one or more points along the length of the conveyor.

Bracing. Members used to stabilize the supporting structure.

Bridge Girder. Crane member on which carriers or trolleys travel, horizontally mounted between and supported by the end trucks.

Bucket Conveyor. Any type of conveyor in which the material is carried in a series of buckets.

Bridle Wire Rope Sling. A sling composed of multiple wire rope legs with the top ends gathered in a fitting that goes over the lifting hook.

Bunker. A large bin or compartment for the storage of bulk materials.

Capacity (Rated Load). Maximum load in tons of 2,000 pounds each for which the hoist is designed and built by the manufacturer.

Carrier:

- A device of various types, attached to or hung from trolleys to support the load;
- The receptacle in which objects are placed for transmittal through a pneumatic tube system.

Carrier Trolley. An assembly with wheels which runs on monorail track or crane girders and supports the load and carries the hoisting mechanism.

Carrier and (or) Trolley Travel Clamp. A suspension fitting used to support tracks from an overhead structure fastened to the structure by means of pressure rather than welding or direct bolting.

Car Unloader. A type of conveyor in which one or more chains acts as the conveying element. A British term for trolley conveyor.

Chain Guide. A device that guides the load chain around the load sprocket.

Chute. A trough through which bulk materials or objects are directed and lowered by gravity. The trough may be open or enclosed, straight or curved.

Collector Wheel. That part of a current collector that makes contact by rolling on the conductor bar or wire.

Conveying Medium. That portion of a conveyor which moves or carries materials, packages, or objects.

Conveyor:

- *Apron Conveyor.* A conveyor in which an apron forms the moving bed.
- *Declining Conveyor.* A conveyor transporting down a slope.
- *En Masse Conveyor.* A conveyor comprised of a series of skeleton or solid flights on an endless chain or other linkage which operates in horizontal, inclined, or vertical paths within a closely fitted casing for the carrying run. Bulk material is conveyed and elevated in a substantially continuous stream with a full cross section of the casing.
- *Extendible Conveyor.* A conveyor which may be lengthened or shortened while in operation to suit operating needs.
- *Flight Conveyor.* A type of conveyor comprised of one or more endless propelling media, such as chain, to which flight are attached, and a trough through which material is pushed by the flights.
- *Mobile Conveyor.* Conveyors supported on structures which are movable under their own power and include, but are not limited to, radial sand winged stackers, reclaiming conveyors, and shiploaders. These conveyors normally handle bulk material.
- *Oscillating Conveyor.* A type of vibrating conveyor having a relatively low frequency and large amplitude of motion usually powered by a rotating eccentric.
- *Overland Conveyor.* A single or series of belt conveyors designed to carry bulk material across country, usually following the general contour of the land.
- *Portable Conveyor.* Any type of transportable conveyor, usually having supports which provide mobility.
- *Pusher Bar Conveyor.* Two endless chains cross connected at intervals by bars or rotatable pushers which propel the load along the bed or trough of the conveyor.
- *Roller Slat Conveyor.* A slat conveyor using rollers for slats.
- *Screw Conveyor.* A conveyor screw revolving in a suitably shaped stationary trough or casing fitted with hangers, trough ends, and other auxiliary accessories.
- *Shuttle Conveyor.* Any conveyor such as a belt, chain, apron, screw, etc., in a self-contained structure, movable in a defined path parallel to the flow of the material.
- *Slat Conveyor.* A conveyor employing one or more endless chains to which non-overlapping, non-interlocking spaced slats are attached.

- *Suspended Tray Conveyor.* A vertical conveyor having one or more endless chains with suitable pendant trays, cars, or carriers which receives objects at one elevation and delivers them to another elevation.
- *Tow Conveyor.* An endless chain supported by trolleys from an overhead track or running in a track at the floor with means for towing floor supported trucks, dollies, or carts.
- *Vertical Articulated Platform Conveyor.* A type of vertical conveyor in which sections of articulated slat conveyor apron form rigid platforms for vertical movement in continuous flow. The platforms are flexible in but one direction and they assume a vertical position on the non-carrying run to minimize space requirements.
- *Vertical Chain Conveyor, Opposed Shelf Type*. Two or more vertical elevating-conveying units opposed to each other. Each unit consists of one or more endless chains whose adjacent facing runs operate in parallel paths. Thus each pair of opposing shelves or brackets receives objects (usually dish trays) and delivers them to any number of stations.
- *Vibrating Conveyor.* A trough, tube, or other device flexibly supported and vibrated at a relatively high frequency and small amplitude (usually powered by an electrical or pneumatic impulse) to convey bulk material or objects.
- *Wheel Conveyor.* A series of wheels supported in a frame over which objects are moved manually or by gravity.

Conveyor Screw. The material propelling medium of a screw conveyor consisting of an assembly of helical flights mounted on a pipe or shaft.

Crane:

- *Double Girder.* A crane having two bridge girders mounted between and supported from end trucks.
- *Double Leg Gantry.* A crane whose bridge is supported on two or more legs running on fixed runways.
- *Handpushed.* A crane without mechanical or electrical power which is either pushed or pulled along the track.
- *Interlocking.* A crane with an interlock mechanism on one or both ends enabling it to be mechanically locked to another crane or spur track for the purpose of transferring a carrier from one to the other.
- *Jib.* A fixed crane consisting of a vertical member pivoting on fixed supports at its top and bottom ends, and a horizontal arm fit with a trolley.
- *Single Leg Gantry.* A crane whose bridge is supported on one end by a vertical leg rolling on a fixed runway and on the other end by trucks running on elevated runways.
- *Wheel Mounted.* A crane consisting of a rotating superstructure with power plant, operating machinery, and boom mounted on a base or platform equipped with axles and rubber-tired wheels for travel. The base is usually propelled by the engine in the superstructure, but it may be equipped with a separate engine controlled from the superstructure.

Deflector:

- A device across the path of a conveyor placed at the correct angle to deflect objects;

- A plate inserted in the necessary structural, mechanical, and electrical parts which provides the motive power for a conveyor, monorail, crane, etc.

Derrick:

- *"A"-Frame Derrick.* A derrick whose boom is hinged from a cross member or pedestal between the base of an upright "A" frame. The point of the "A" frame is braced or guyed to the top of the boom which serves as the lift point.
- *Basket Derrick.* A boomless derrick whose lift mast is held within a support frame by a series of guys running from its base to high points on the support structure. A second series of multiple guys are reeved from the top of the lift mast to the support frame for use in varying the position of the lift point at the mast top both longitudinally and in elevation.
- *Breast Derrick.* A boomless derrick whose lift mast has the form of a truncated "A" frame with a tackle block reeved at its top end. The inclination of the lift frame can be varied by reeved guy ropes.
- *Chicago Boom Derrick.* A boom attached externally to a hoist structure. The boom is hinged at its attached point and carries its own boom fall and load fall.
- *Ginpole Derrick.* A boomless derrick whose lift mast is guyed at its top by a fall line by which the load-boom may be moved in one or more directions.
- *Guy Derrick.* A fixed pivot derrick consisting of a mast guyed at its top and capable of non-continuous rotation through 360 degrees. Its boom is hinged to the mast and provided with boom and lift falls.
- *Shear Leg Derrick.* A boomless derrick similar to a breast derrick. The mast, wide at the bottom and narrow at the top, is hinged at its bottom and uses a multiple reeved toppings fall for changing the load lift radius. The load tackle is secured to the mast top.
- *Stiff Leg Derrick.* A derrick, similar to a guy derrick except that the mast is held in place by two or more stiff members (stiff legs) set to resist both tensile and compressive forces. Sills are generally provided to connect the lower ends of the stiff legs to the top of the mast.

Drift Point. A point on a travel motion controller which releases the brake while the motor is not energized. This allows coasting before the brake is set.

Dynamic. A method of controlling crane motor speeds when in the overhauling condition to provide a retarding force.

Dynamic Loading. Loads introduced into the machine or its components by forces in motion.

Electrification. The track mounted electrical conductor system by which the moving equipment receives its electrical power.

End Stop. A positive device located at the end of a track or crane bridge to prevent the carrier from running off the end of the track or bridge.

End Truck. The assembly consisting of the truck frame and wheels which support the crane girders and allow movement along the runway.

Flange, Load Carrying. The lower flange of the monorail systems or underhung crane track on which the load bearing wheels roll.

Flight:

- Plain or shaped plates suitable made for attachment to the propelling medium of a flight conveyor;
- A term applied to any conveyor in a tandem series.

Fork, Safety. A mechanical device for use on interlocking transfer equipment to mechanically prevent passage of a carrier when the elements are not securely locked.

Gantry (A-Frame). A structural frame, extending above the superstructure, to which the boom support ropes are reeved.

Gas-Electric Truck. An electric truck that uses a gasoline or LP gas-engine-driven generator.

Gate. A device or structure which stops or regulates the flow of material. Also, a section of conveyor equipped with a hinge mechanism for movable service often called a hinged section.

Gondola. An open-top freight car with sides and ends.

Grating:

- A coarse screen made of parallel or crossed bars to prevent passage of oversize material; or
- A series of parallel or cross bar units fastened to or propelled by the conveying medium, used for carrying large lump-sized bulk material or objects. Usually used to permit passage of air for cooling or heat to maintain temperature.

Hanger Rod. Steel rods, which, together with other fittings, are used to suspend the track from the supporting structure.

Headroom. Distances from saddle of load hook in highest position with full load to saddle of top hook.

Hopper. A box having a funnel-shaped bottom or a bottom reduced in size, narrowed, or necked to receive material and direct it to a conveyor, feeder, or chute.

Inactive Controls. Those controls that are not a part of or contributing to the present or future contemplated use of the conveyor or system, as presently installed and wired.

Jib. An extension attached to the boom point to provide added boom length for lifting specified loads. The jib may be in line with the boom or offset to various angles.

Lever Pull. Average number of pounds of effort exerted by the operator on the end of the lever to raise or move the rated load.

Lift. Distance between the upper and lower limits of travel of the load hook.

Lift Out Section. A section of track which can be raised out of the line of the track to make an opening through which a door can pass.

Load Carrying Flange. The lower flange of the monorail or underhung crane track on which the load bearing wheels roll.

Load Center. The point at which the rated capacity can be carried, commonly 2 inches from the fork tips.

Main Hoist. The hoist mechanism provided for lifting the maximum rated load.

Man Trolley. A trolley which has an operator's cab attached.

Master Switch. A switch which dominates the operation of contactors, relays, or other remotely operated devices.

Railing Guard. A structure consisting of rails and posts, including top rail, center rail, posts, and where required, toeboards.

Rail Joint. The point at which two sections of track are joined together.

Rated Speed. The speed of the conveyor, as established by the manufacturer or a qualified engineer, at which safe and satisfactory service can be expected.

Regenerative. A form of dynamic braking in which the electrical energy generated is fed back into the power system.

Remote Location. Any location, with respect to the conveyor, from which the presence or position of personnel relative to the conveyor cannot be readily determined from the operator's station.

Roller Turn. A series of vertical rollers mounted in a frame to guide conveyor chain around a horizontal curve.

Safety Lug. A mechanical device fixed securely to the end truck which will prevent the crane from falling in the event of a wheel or axle failure.

Shear Point or Line. The point at which (or the line along which) parts of the human body can be caught, trapped, or pinched between moving parts or objects.

Skip Bucket. The tub or bucket used for containing the material conveyed by a skip hoist.

Skip Hoist. A bucket or car operating up and down a defined path receiving, elevating, and discharging bulk materials.

Slack Cable Switch. A device installed on skip hoists to automatically shut off the power supply when the hoisting cable becomes slack or has slack due to accident or jamming.

Slat. A member supported between chains in a slat conveyor. The series of slats form the conveying bed.

Span. The horizontal distance between the centers of the runway tracks.

Speed. The length of belt, chain, cable, or other linkage which passes a fixed point within a given time. It is usually expressed in terms of "feet per minute," "meters per second," etc. In the case of a Rolling Chain Conveyor, the load is moved at a rate double the chain speed. In screw conveyors, the speed is expressed in terms of "revolutions per minute" and the speed at which material is conveyed is dependent upon speed, pitch of the screw, type of flight, angle of inclination, and nature of material.

Spill Guard. A stationary device of sufficient strength and capacity to catch, retain, and contain any spillage which might cause personal injury from a conveyor passing overhead.

Sprocket, Idler. A freely rotating device that changes direction of the load chain.

Spur Track. A fixed track arranged to interlock with an adjacent crane girder to permit passage of carriers from the spur track to the crane and vice versa.

Stacker. A conveyor adapted to piling or stacking bulk materials, packages, or objects.

Switch Baffle, Electric. A track switch wired in such a way that electric current is cut off from approaching motor driven equipment unless the track switch is properly set for passage of the carrier.

Switch, Cross-track. A track switch containing one straight section of moving track pivoted in the center, which can be rotated to align it with other crossing tracks to allow passage of a carrier through the junction without changing the direction of the carrier motion.

Switch, Glide and (or) Slide. A track switch with a movable inner frame containing straight or curved sections of track. The inner frame can be slid to align these sections of track with other tracks to permit routing carriers from one track to another, usually changing the direction of motion of the carrier.

Switch, Master. A switch which dominates the operation of contactors, relays, or other remotely operated devices.

Switch, Rotary. A track switch with a movable inner frame containing straight or curved sections of track. The inner frame can be rotated around a vertical axis to align these tracks with other tracks for routing carriers from one track to another.

Switch, Tongue. A track switch containing one straight section of track pivoted at one end which can be swung to various positions to connect with other tracks for transfer of carriers from one to the other.

Tackle. An assembly of ropes and sheaves arranged for hoisting.

Tag line, Electrical. An electrical conductor system employing flexible cables.

Take-Up. The assembly of the necessary structural and mechanical parts which provides the means to adjust the length of belts, cables, chains, etc., to compensate for stretch, shrinkage, or wear and to maintain proper tension.

Tow Pin. A movable or fixed member on a truck, dolly, or cart used to engage a pushing or pulling dog on a floor mounted tow conveyor.

Track Curves. Curved sections of monorail track used to change the horizontal or vertical direction of carrier travel.

Track Hangers. A suspension fitting fastened to the track.

Transit. The moving or transporting of a crane from one job site to another

Transfer Car. Any wheeled device used for transferring loads from one conveyor line to another. May be manually or automatically operated.

Transfer Mechanism. Any mechanism that transfers objects onto or off a conveyor line or from one conveyor line to another.

Tray. A car, carrier, or pallet usually suspended from the moving element of the conveyor.

Whipline (Auxiliary Hoist). A separate hoist rope system of lighter load capacity and higher speed than provided by the main hoist to provide crane dexterity.

Attachment 3

CHECKLIST -- MATERIALS HANDLING AND STORAGE EQUIPMENT

This is not an all-inclusive checklist. It simply highlights some critical items in this standard. Other requirements exist in the standard that are not included in the checklist; whereappropriate, MAJCOMs, DRUs, FOAs, local safety staffs, and supervisors will add to this checklist to include command or mission and (or) work area unique requirements or situations.

A3.1. Has a training program been developed on manual listing and carrying methods and techniques and is this training documented according to AFI 91-301? (Reference paragraph **1.2.1.**)

A3.2. Are annual inspections of manual hoisting or pulling devices documented with identification tags and include appropriate information? (Reference paragraph **2.2.2.3.**)

A3.3. Have training outlines been developed, qualified personnel identified as instructors, and has training on the operation of powered industrial trucks been conducted? (Reference paragraph **3.2.4.**)

A3.4. Are safety pallets used to lift personnel designed correctly? (Reference paragraph**3.2.4.6.**)

A3.5. Are gasoline and (or) diesel powered industrial trucks or other material handling equipment provided appropriate parking and refueling areas? (Reference paragraphs **3.3.1.**, **3.3.3.**, and **3.3.4.**)

A3.6. Are battery charging areas for electrically powered material handling equipment designed according to this standard and the NFPA 503, Section 5-3? (Reference paragraph **3.3.2.**)

A3.7. Do the conveyors have all of the required design and safety features required by this standard? (Reference paragraph **4.2.**)

A3.8. Are all personnel trained on procedures for operating conveyors? (Reference paragraphs **4.2.4.** and **4.2.5.**)

A3.9. Are hoists operated only by qualified personnel who are trained and qualified to use the equipment? (Reference paragraph **5.2.3.1.1.**)

A3.10. Are there records of all operational, rated, and proof load tests? (Reference paragraph **5.2.4.1.**)

A3.11. Have lockout and (or) tagout procedures been developed for use with maintenance activities? (Reference paragraph **5.2.4.3.** and AFOSH Standard 127-45)

A3.12. Are hooks used with hoisting equipment inspected daily or before each use? (Reference paragraph **5.2.5.1.**)

A3.13. Are records of inspections of hoists, chains, and ropes maintained? (Reference paragraph **5.2.5.4.**)

A3.14. Are slings inspected each month and documented? (Reference paragraph **6.2.2.**)

A3.15. Are slings proof tested at 200 percent of rated capacity and a record of the most recent test maintained on file? (Reference paragraph **6.2.3.1.**)

A3.16. Is the rated load plainly marked on each crane? (Reference paragraph **7.2.2.2.**)

A3.17. Do the pendant or cab hoist controls use the compass points for directional identification? (Reference paragraph **7.2.2.7.**)

A3.18. Is there an approved hand fire extinguisher located in the cab of the crane? (Reference paragraph **7.2.2.10.**.)

A3.19. Are personnel trained and identified to operate cab and pulpit cranes? (Reference paragraph **7.2.4.1.**)

A3.20. Are the standard hand signals posted on or near all cranes? (Reference paragraphs **5.2.2.2.**. and **7.2.4.6.**. and **Figure 7.1.**)

A3.21. Are hazardous energy control (lockout and (or) tagout) procedures developed and used during maintenance activities? (Reference paragraph **7.2.5.** and AFOSH Standard 127-45)

A3.22. Have all cranes received the required load tests and are these test reports documented and available? (Reference paragraph **7.2.5.6.2.**)

A3.23. Is there a clearly legible rating chart located in view of the operator in the crane cab? (Reference paragraph **8.2.1.2.1.**)

A3.24. Is there a warning permanently posted in the cab of the crane which states: “DANGER HIGH VOLTAGE, DO NOT OPERATE WITHIN 10 FEET OF ELECTRIC POWER LINES?” (Reference paragraph **8.2.1.2.11.**)

A3.25. Have man-rated cranes been approved prior to acquisition? (Reference paragraph **8.2.1.2.13.**)

A3.26. Are daily, monthly, and annual inspections being conducted and documented? (Reference paragraph **8.2.2.**)

A3.27. Are records of all load tests available? (Reference paragraph **8.2.3.1.5.**)

A3.28. Are energy control (lockout/tagout) procedures developed and used during maintenance activities? (Reference paragraphs **8.2.3.2.** and AFOSH Standard 127-45)

A3.29. Is there a procedure developed to provide safe operations in the vicinity of electrical power lines? (Reference paragraph **8.2.6.39.**)

A3.30. If an approved crane is used to lift personnel, is the platform used to suspend personnel designed correctly? (Reference paragraphs **8.2.6.50.** and **9.6.**, and 29 CFR 1926.550)

A3.31. Are wire rope inspections conducted at least monthly and records maintained on file by the user and the agency responsible for hoist maintenance and inspections? (Reference paragraphs **9.1.3.1.** and 5.2.4.1.)

A3.32. Are chains inspected before each use and monthly and are these inspections documented? (Reference paragraph**9.2.1.4.**)

A3.33. Is a preventive maintenance program established for derricks and are these maintenance activities documented? (Reference paragraph **10.4.**)

A3.34. Are energy control (lockout/tagout) procedures established and followed during maintenance tasks? (Reference paragraph **10.4.2.1.4.**)